INDEXED

International Marine Engineering

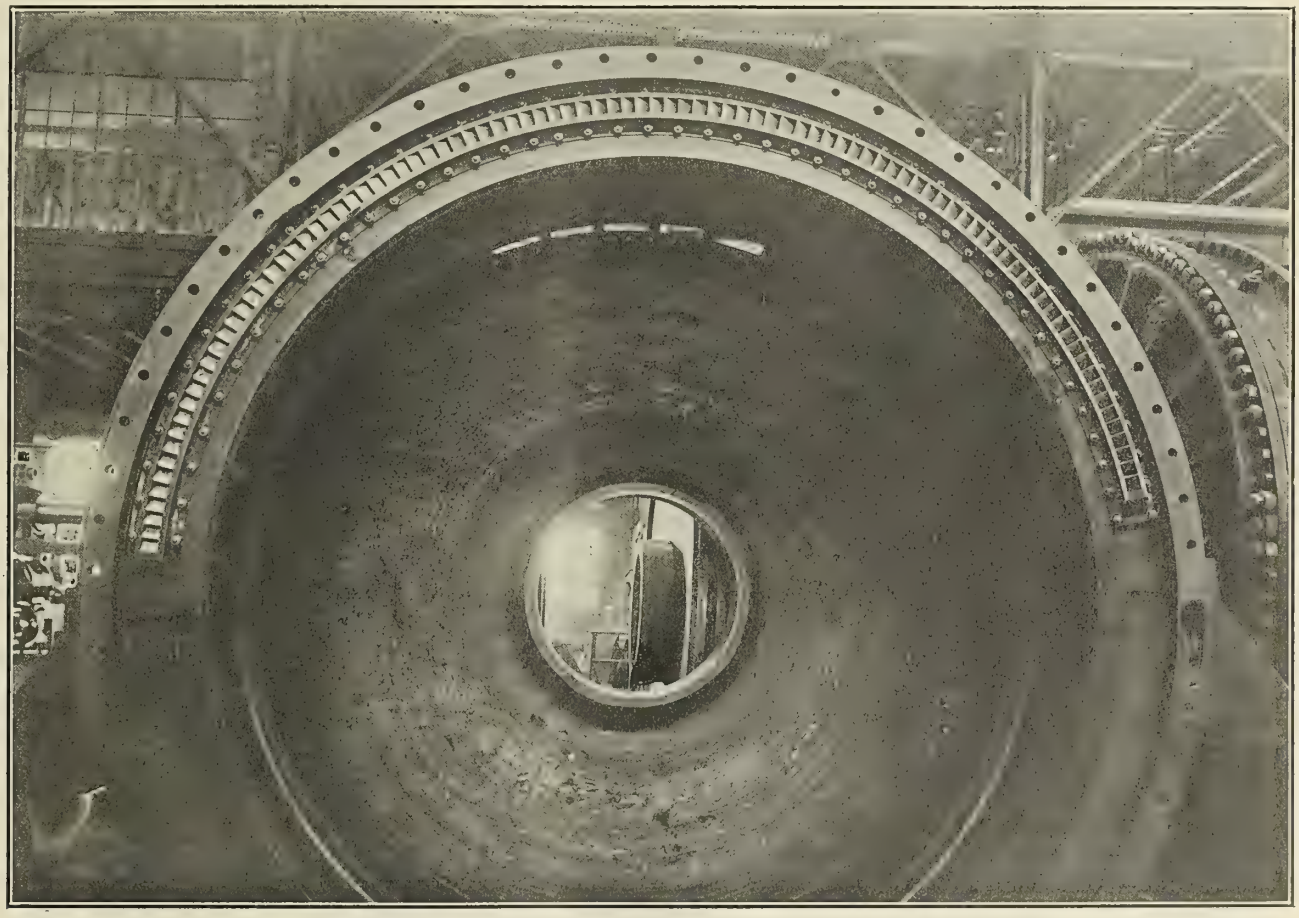
OCTOBER, 1906.

TWIN SCREW TURBINE STEAMSHIP CREOLE.

The *Creole* is a steel steamship of the hurricane deck type, specially designed and constructed for the Atlantic Steamship Line of the Southern Pacific Company, by the Fore River Shipbuilding Company, of Quincy, Mass. She has a straight stem and semi-elliptical stern, and in elevation shows one large smoke stack and two short pole masts. She has a large superstructure on top of hurricane deck amidships, and superimposed deck houses.

in which is stowed fresh water and also ballast water. The hull is subdivided into watertight compartments by seven transverse bulkheads, and the cargo holds have been arranged on the girder system, which eliminates the usual hold stanchions interfering with the stowage of cargo.

The hull has been specially designed to provide against the weaknesses inherent in hurricane deck vessels having large cargo



DIAPHRAGM AND NOZZLES OF 120-INCH CURTIS TURBINE FOR STEAMSHIP CREOLE, SHOWING INSIDE OF THE CYLINDRICAL CASING.

THE HULL.

The following are the principal dimensions of this vessel:

Length over all	440 feet
Length between perpendiculars	416 feet
Breadth molded	53 feet
Depth molded, to upper deck	37 feet
Length of superstructure	182 feet

The vessel is intended as a first class passenger and freight steamship. The structural arrangement provides for three complete steel decks running all fore and aft, and an inner bottom carried about three-fourths of the length of the vessel amidships,

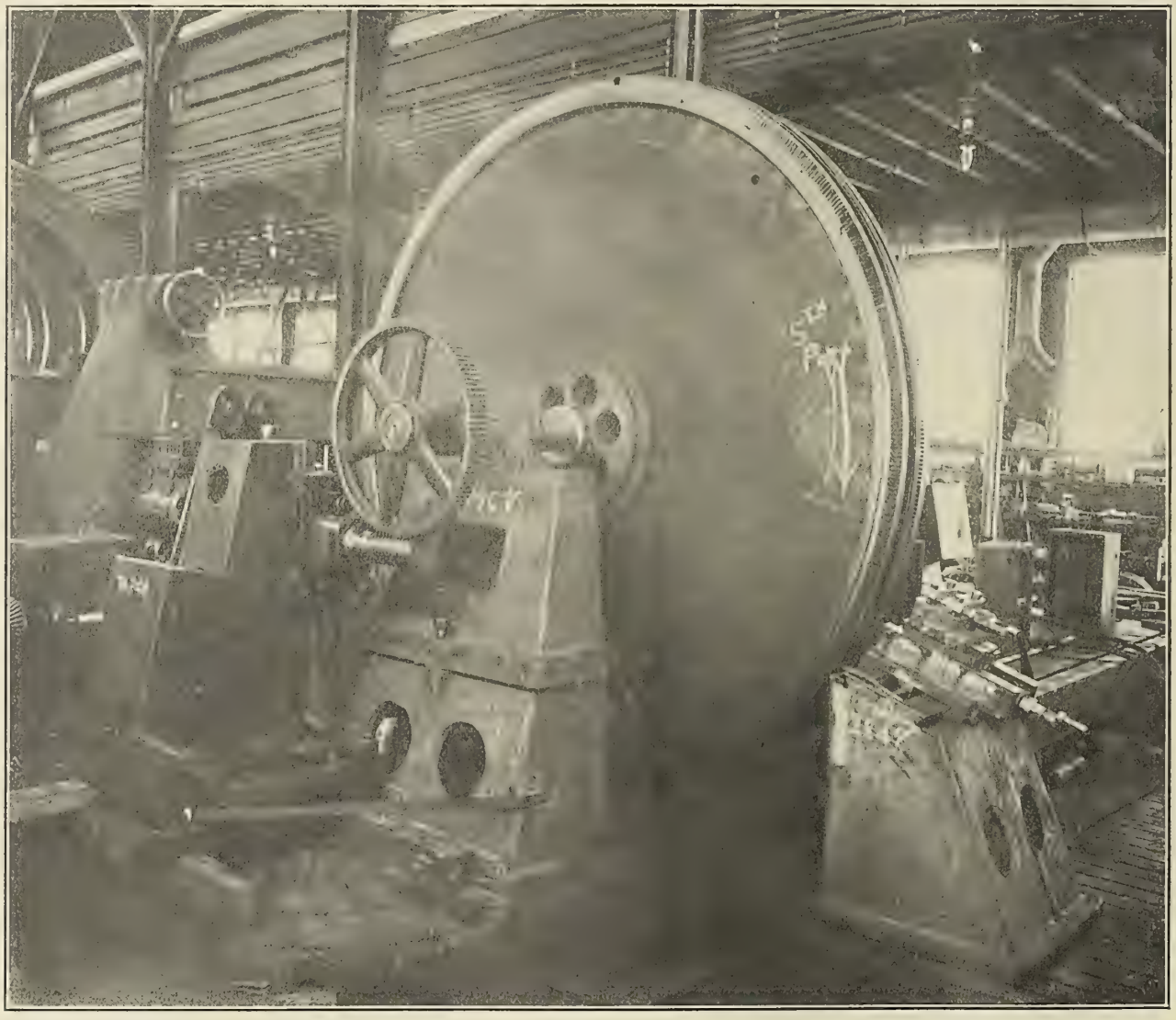
ports in wake of the over-all hatches on hurricane deck. The provision for extra strength consists in constructing the deck mentioned as the strength deck for about one-half the length amidships, and at the ends of the superstructure it is continued down to main deck by specially designed hogging girders, and from thence forward and aft the main deck is treated as the strength member. It will be obvious that this provides the structure with immense strength as compared with existing hurricane deck vessels.

On superstructure the midship houses are of comparatively light construction, specially braced to take the racking stresses

incident to their location on ship. In addition, expansion joints are fitted at forward and after ends of superstructure, to relieve these erections of undue stresses.

The subdivision of the vessel mentioned arranges for four cargo holds in addition to orlop, lower and main 'tween decks, the lower and main 'tween decks being pierced with large hinged cargo ports providing for the expeditious handling of cargo, in addition to which there are four especially large over-all hatches extending the full width of hurricane deck, giving roomy exits for handling freight.

The main deck provides accommodation at the extreme forward end for 252 passengers, in addition to which 168 passengers can



CALKING DEVICE FOR SETTING BUCKET SEGMENTS IN THE RIMS OF THE ROTORS OF THE 120-INCH TURBINES.

be slung in hammocks, should occasion arise. Amidships on this deck have been fitted up quarters for waiters, pantrymen, cooks, etc., and alongside of the engine hatch are large insulated spaces for cold storage. After end of main deck has been arranged with second class staterooms.

The upper or hurricane deck has two steel quarter houses, one built forward and the other aft; the forward one containing shelter for four steam hoisters and also fitted up as wash room and toilet for steerage passengers, and the after one as seamen's quarters, mess room, wash places, etc., in addition to inclosing four cargo hoisters.

Amidships on upper deck a steel superstructure is constructed, having arranged at its forward end the first class dining saloon, with a seating capacity for 164 people. This saloon has a grand stairway at the after end leading to saloon deck, finished in mahogany. The saloon generally has mahogany wainscoting and furniture, and is finished in white, including panels and ceiling. The upholstery, tapestry and hangings have a dark green color effect, and the saloon is lighted around three sides by exceptionally large hinged air ports.

Adjoining dining saloon there has been arranged a commodious serving pantry with steam table, plate warmer, urns and all usual accessories and utensils commonly found in this department. The pantry is in close connection by spacious passages with the general galley.

At the after end of boiler casing, and at the sides of ship abreast this casing, the scullery, bakery, wine room, steward's stores and linen locker have been arranged.

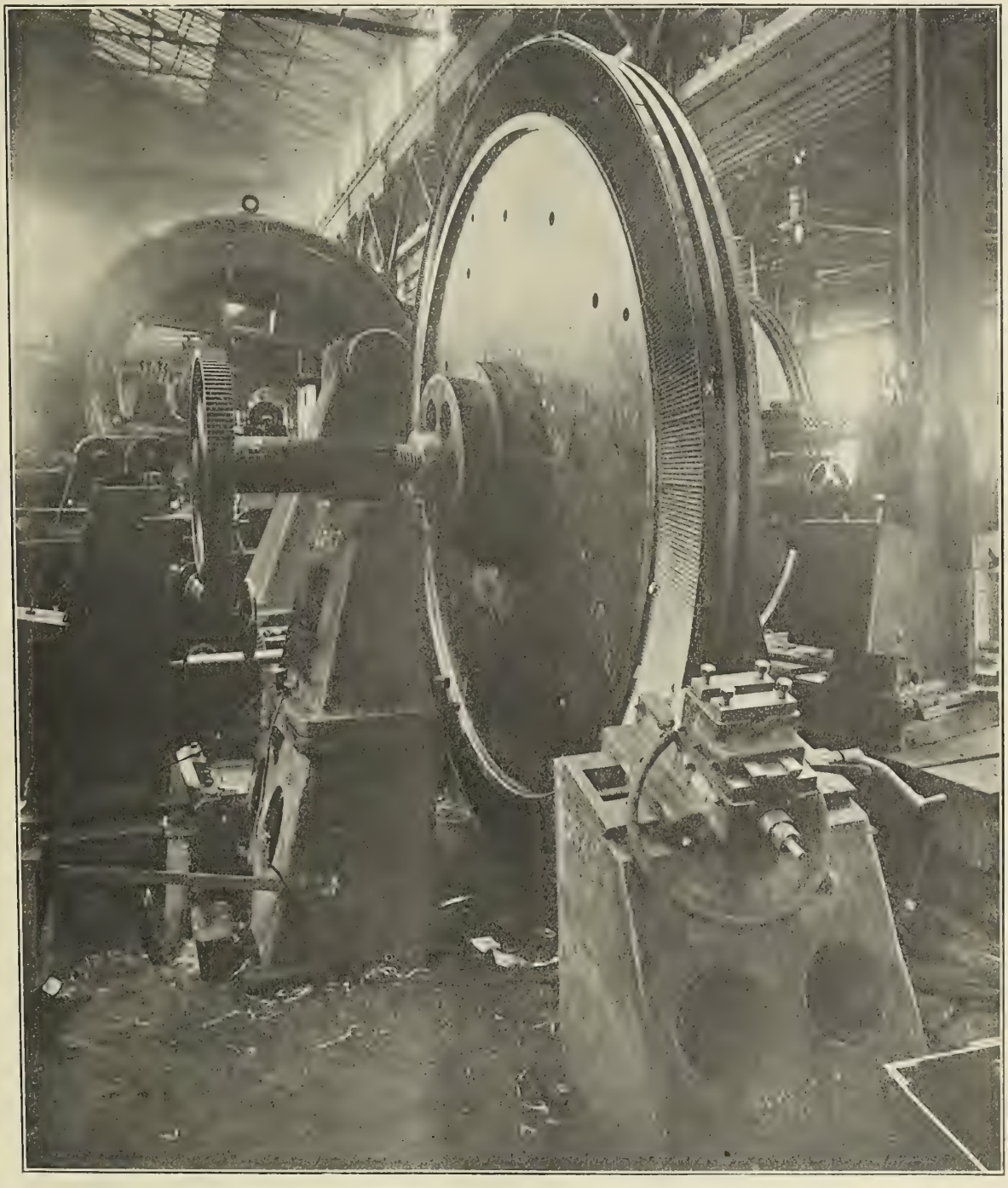
Cold stores have been arranged at the forward end of the engine casing; and abreast of this casing, on port side, have been fitted up firemen's and coal passers' quarters and messes; and on the starboard side are engineers' staterooms, bath room, lavatories, etc., while at the after end of casing is the officers' mess.

Accommodations for 38 second class passengers are provided in a steel deckhouse at the extreme after end of vessel, comprising 19 staterooms, dining room (seating 44 people), pantry, and lavatories. A spacious promenade for the second class passengers is set apart on this deckhouse.

The saloon deck is formed by top of superstructure and extends for about 176 feet amidships. On this deck a steel house is

constructed, inclosing accommodations for first class passengers, and comprising 34 staterooms, bath rooms, lavatories and a large library at the extreme forward end of staterooms. These staterooms are each two-berth rooms fitted with metallic berth fronts, side lights with ventilator above, colored glass, leaded sash, blinds, etc., and wash basins of the most approved type.

The library is 28 by 15 feet, and fitted up with tables, desks and lounge seats. The color effect is varying shades of blue.



ANOTHER VIEW OF THE CALKING DEVICE FOR ATTACHING BLADE SEGMENTS TO ROTORS.

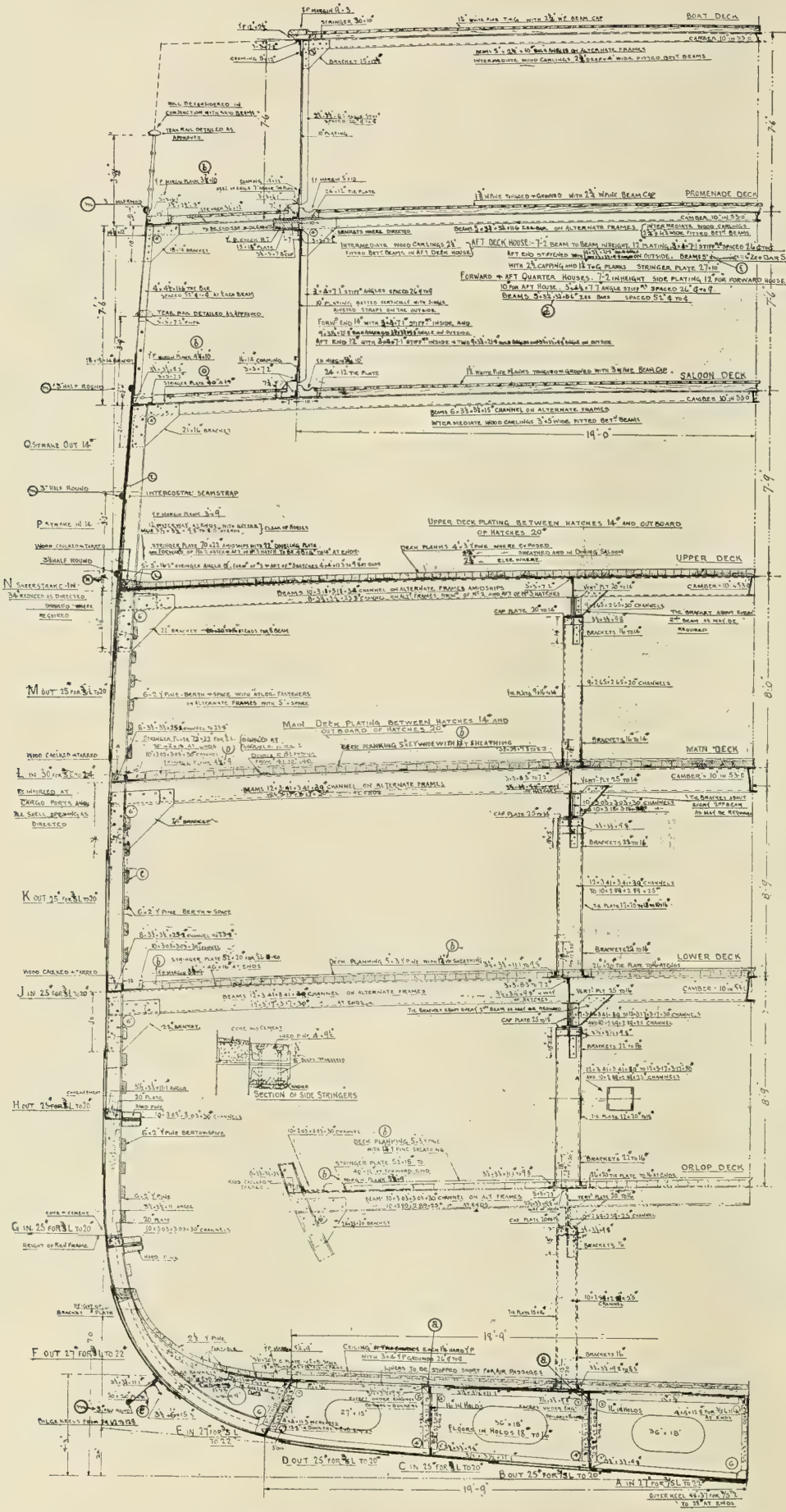
On top of saloon deck, the promenade deck house has been arranged inclosing 33 staterooms, some of which are en suite, with parlor and bath rooms. Two grand stairways provide access to saloon deck, and ample provision is made for bath rooms, lavatories, etc., amidships in this house.

At the extreme after end of promenade deck house the smoking room is located in a space occupying 25 by 13 feet, and is fitted up in a luxurious manner with oak wainscoting and panels above, the whole having a green color effect in old Dutch finish. Adjacent to the smoking room on port and starboard sides respectively are placed the bar and barber shop.

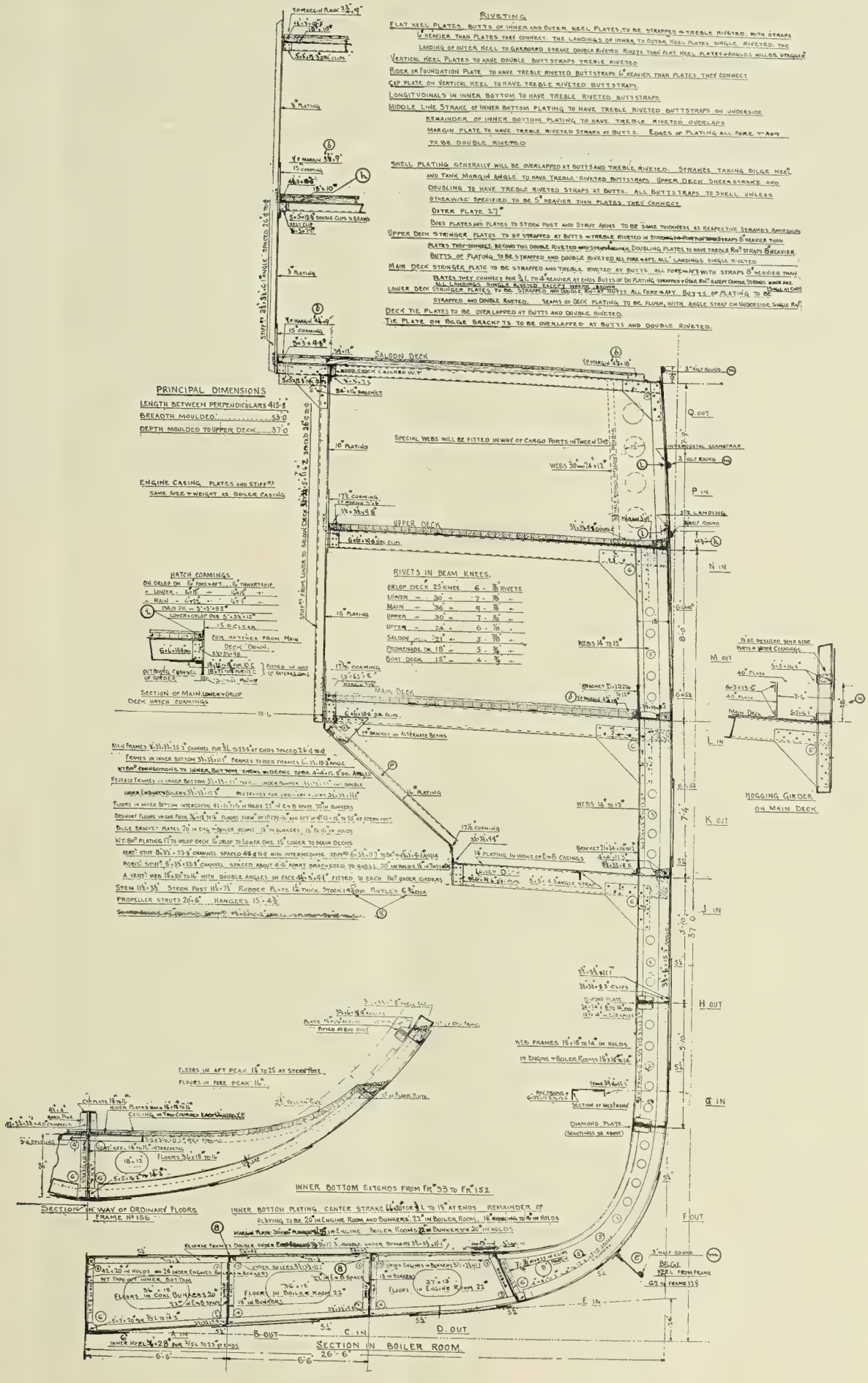
The pilot house and officers' cabins are placed on boat deck. On this deck there are also arranged eight 27-foot metallic life boats with Mallory type davits for their expeditious operation.

Officers' and first and second class passengers' accommodations are heated throughout by electric heaters. Baths, showers and wash hand-basins are fitted throughout with hot and cold fresh and salt water connections. Holds and accommodations are "naturally" ventilated throughout.

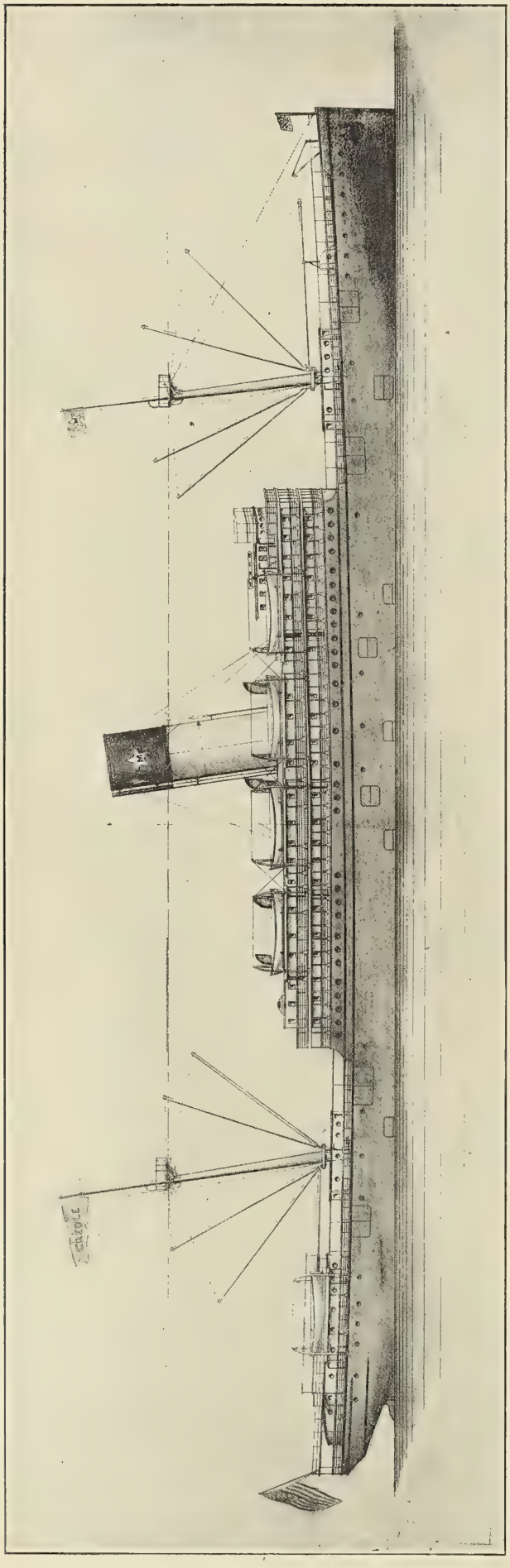
The cargo is handled through four large over-all hatches and operated by sixteen 7½-ton capacity cargo derricks, and in addition one 20-ton cargo derrick supplied for handling exceptionally heavy lifts. These derricks are operated by eight double drum steam winches of the frictional gear type, manufactured by the



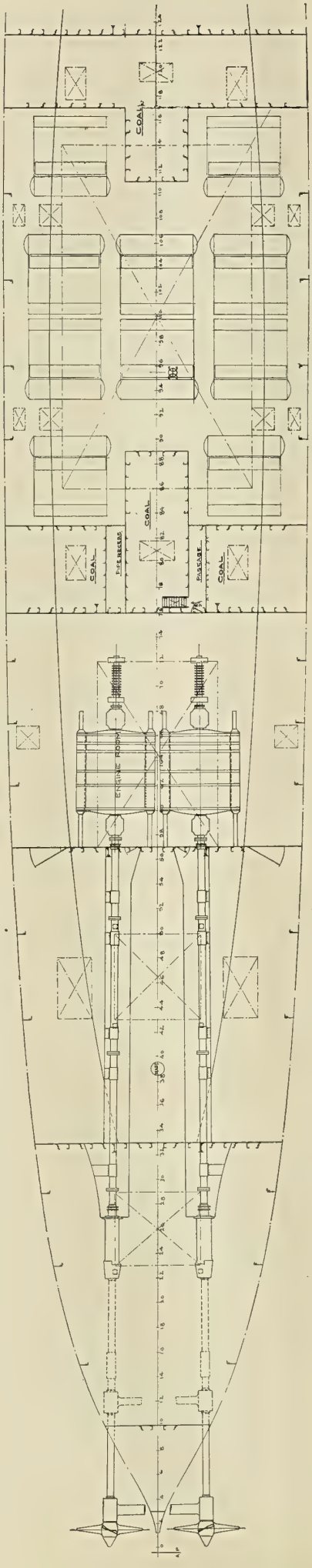
SCANTLING SECTION OF SHIP AT MID LENGTH OF HULL.


RIVETING
PRINCIPAL DIMENSIONS
LENGTH BETWEEN PERPENDICULARS 415'-8"
BREADTH MOULDED ..... 53'-0"
DEPTH MOULDED TO UPPER DECK .... 37'-0"
ENGINE CASING PLATES AND STIFFRS SAME SIZE T WEIGHT AS BOILER CASING
HATCH COAMINGS
RIVETS IN BEAM KNEES.
SALOON DECK
UPPER DECK
MAIN DECK
LOWER DECK
SECTION OF MAIN LOWER & ORLOP DECK HATCH COAMINGS
HOGGING GIRDER ON MAIN DECK
FLOORS IN AFT PEAK 18" TO 25 AT STERN POST
FLOORS IN FORE PEAK 16"
INNER BOTTOM EXTENDS FROM FR 33 TO FR 152
SECTION IN WAY OF ORDINARY FLOORS FRAME Nº 156
SECTION IN BOILER ROOM.

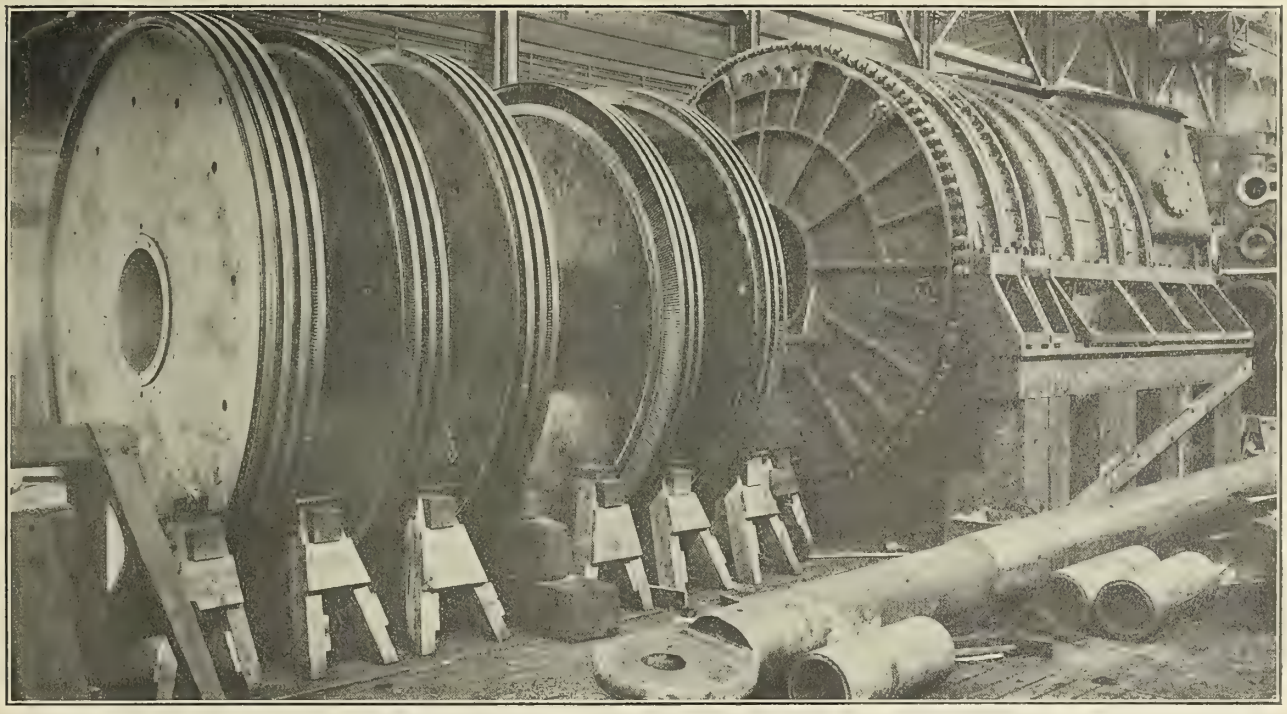
CROSS SECTION OF THE SCANTLINGS IN WAY OF BOILER ROOM.



THE NEW SOUTHERN PACIFIC STEAMER CREOLE, PROPELLED BY CURTIS TURBINES, AND BUILT BY THE FORE RIVER SHIPBUILDING COMPANY.



PLAN OF THE HOLD, SHOWING ARRANGEMENT OF THE TEN BABCOCK & WILCOX BOILERS AND TWO CURTIS PROPELLING TURBINES AND SHAFTING.

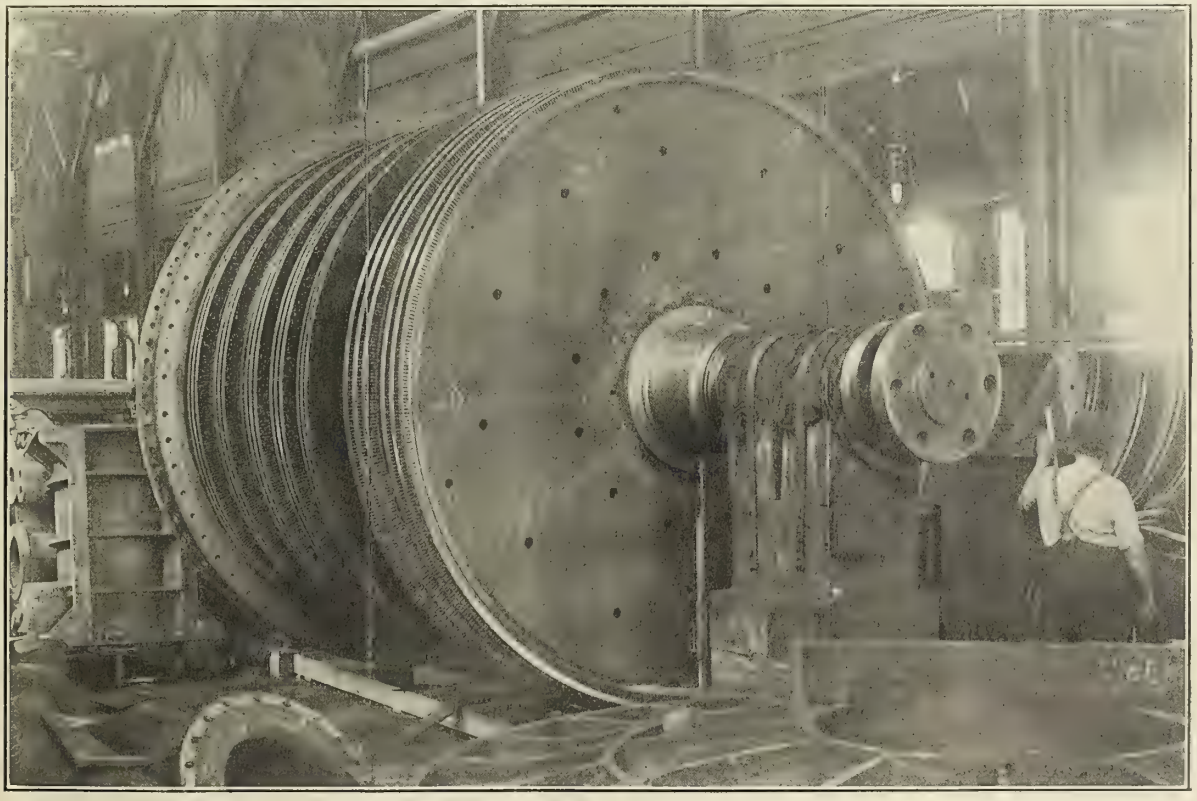


WHEELS READY FOR ASSEMBLING ON SHAFT. TURBINE CASING AT THE RIGHT.

Hyde Windlass Company. It should be noted that the pole masts are specially designed as king posts to take cargo derricks, and for this purpose the usual standing rigging, such as stays, shrouds and backstays, has been dispensed with.

The steam windlass gear consists of a specially heavy windlass of Hyde manufacture, with two vertical shafts driven by worm gearing direct from a worm located on engine crankshaft. The wildcats for operating cable are placed on the hurricane deck, and the steam engines for operating same are placed on main deck. In addition, these engines operate two warping capstans fitted on either side of forecastle head. A pair of warping capstans are likewise located aft on hurricane deck, operated by steam engine bolted under deck.

The steam steering installation is of the Hyde quadrant type, having engines bolted on the steam tiller, which is keyed to a rudder head of the Brown type. The steering gear is operated from the pilot house by wire rope transmissions to the engine valves, and is, in addition, so arranged that it can be operated by



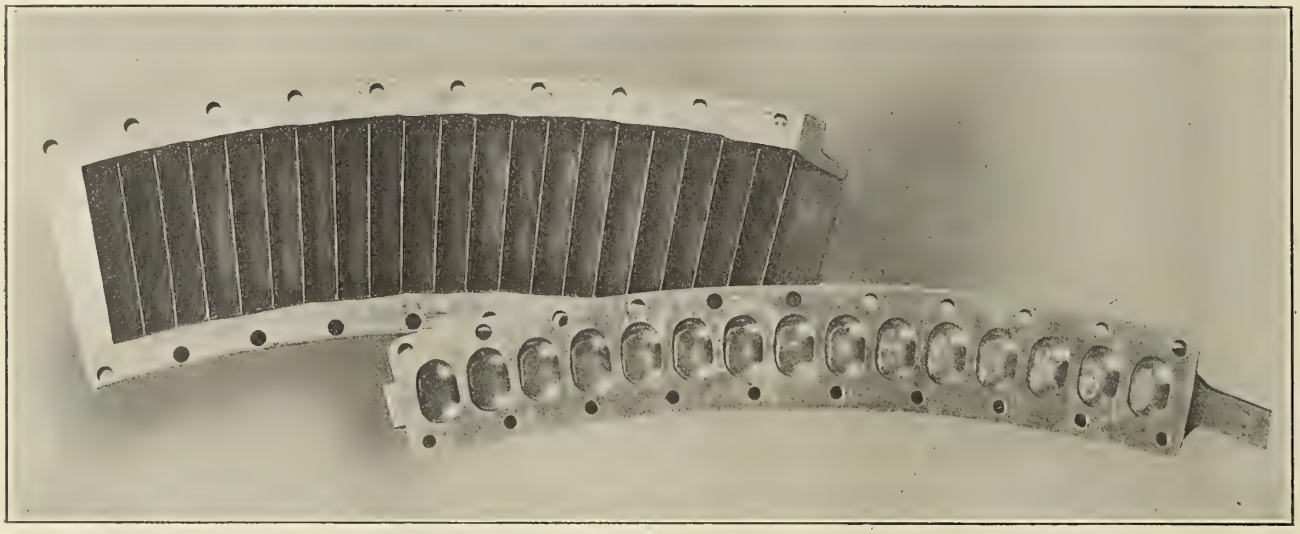
THE ASSEMBLED ROTOR OF ONE OF THE PROPELLING TURBINES, WITH DIAPHRAGMS IN PLACE.

hydraulic telemotor, to enable the vessel to be steered by the telemotor or with the transmission wire leads at will. In addition to above the usual hand and spare tiller steering arrangements are provided, to be used in the event of accident.

Coaling arrangements and boat handling gear are operated by two steam hoisters fitted on boat deck.

THE MAIN ENGINES.

The main propelling engines consist of two 10-foot reversing Curtis turbines, each having a rated capacity of 4,000 brake horsepower at 230 revolutions per minute, when operating at 250 pounds gage at throttle, with 100 degrees F. superheat and 27 inches vacuum. Each turbine has seven ahead wheels and two



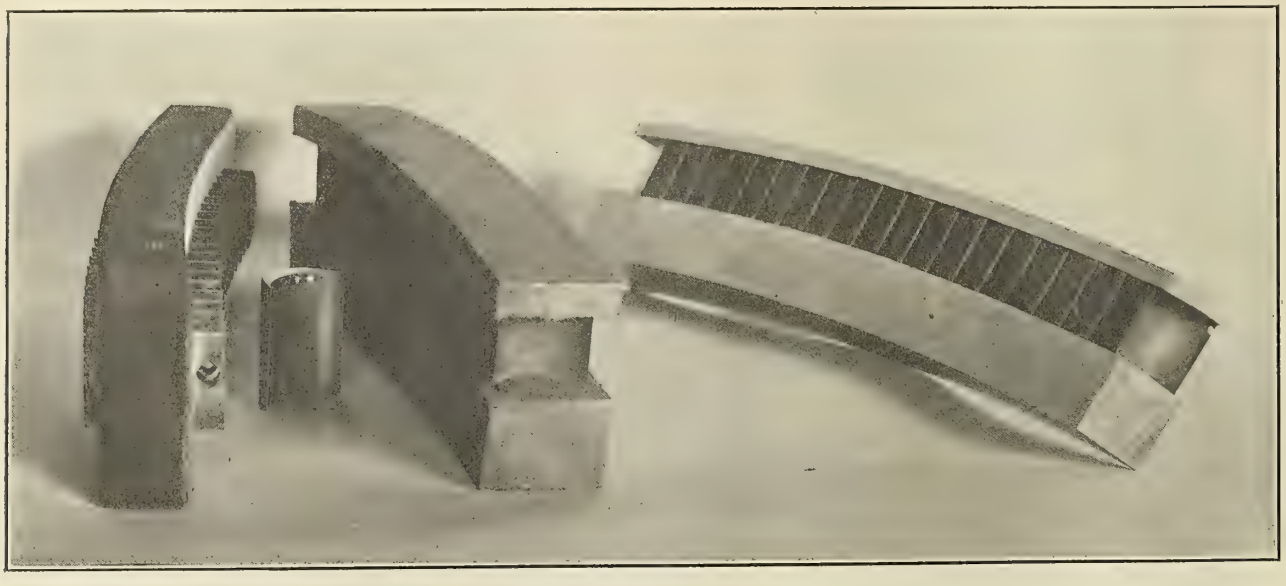
CURTIS TURBINE EXPANSION NOZZLES, FRONT AND BACK VIEWS.

In the engine room there is located a fire extinguishing and disinfecting machine of the Clayton type. This apparatus consists of a generator which can be charged with sulphur, and an air fan operated by steam with pipes leading to the holds, 'tween decks, bunkers, and all parts of the ship where freight or combustible material is carried. In addition to this provision for guarding against fire, there is the usual fire extinguishing installation required by law, which can be operated in conjunction with the Clayton apparatus at will.

Altogether the *Creole* in design, construction, equipment and appointments is probably one of the best and most complete vessels of her class afloat.* The equipment and appointments are of the highest order and the materials and workmanship throughout are of the best.

*She was launched September 23, 1906.

reverse wheels; each wheel has three rows of revolving buckets, except the first stage ahead, which has four rows. All wheels are inclosed in a cylindrical casing provided with diaphragms between the wheels, so that each wheel operates in a separate chamber. The first stage ahead wheel is in the forward end of the casing, and the first stage reverse wheel is in the after end. The seventh stage ahead wheel and the second stage reverse



B A C D

A, BRONZE BUCKET; B, BUCKETS IN CORE READY FOR CASTING ON BANDS; C, BUCKET SEGMENT, ROUGH CASTING; D, FINISHED SEGMENT.

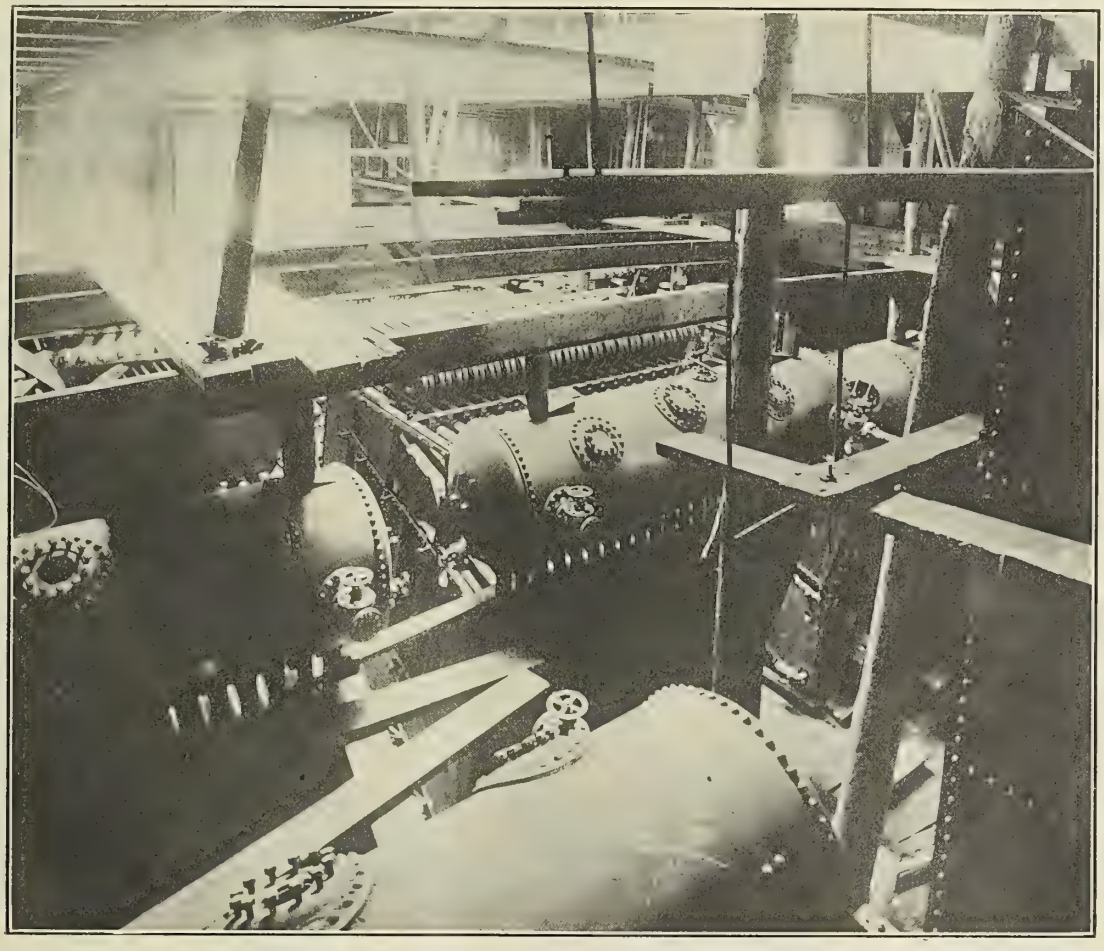
wheel thus come next to each other, and as no diaphragm is between them they operate in the same chamber, which is connected direct to the condenser.

Stationary guide blades are carried on the inside of the casing and project between the rows of revolving buckets. Steam enters through nozzles in the forward head of the casing, and after passing through the buckets and guides of the first stage ahead wheel enters a second set of nozzles in the diaphragm

between the first and second stages; it then passes through the buckets and guides of the second stage wheel to similar nozzles in the diaghragm between the second and third stages, and so on through all the wheels and into the condenser.

The buckets all act on the impulse principle, the steam expanding and receiving its velocity as it passes through the various sets of nozzles in the diaphragms, therefore the pressure is equal on both sides of each wheel, and there is no end thrust due to the steam.

The nozzles on the first stage cover only a part of the circumference, the arc covered being gradually increased in the following stages; also the height of buckets is increased, so that the steam passage is increased in proper ratio, to accommodate the increased volume of the steam as it expands in passing from stage to stage.



BABCOCK & WILCOX BOILERS INSTALLED ON SHIP, SHOWING SUPERHEATERS. BOILER CASING NOT YET FITTED.

Reversing is accomplished by shutting off steam from the ahead nozzles and opening the nozzles of the reverse wheels. This is done by interlocking levers on the operating platform, and the turbine can be instantly thrown from full speed ahead to full speed astern with no danger of injury and with much greater quickness and ease of control than is possible with the reverse motors of reciprocating engines. The reverse wheels will give 50 percent of full power. When going ahead, the reverse wheels run in full vacuum, and the power absorbed by them is negligible.

When the main shaft passes through the ends of the casing a special form of carbon packing is used to prevent steam leakage. Two sets of packing are used, with an annular space between, which is piped to the third stage shell, and has a pressure of only about three pounds above the atmosphere. On the ahead end the leakage of steam past the inside packing flows into the third stage shell, and the outside packing has to resist only the low pressure of 3 pounds, which will produce but the slightest leakage into the engine room. On the reverse end steam flows from the third stage into the annular space between the packings, so that only steam and no air will leak past the inside packing into the condenser, thus preventing the vacuum from being impaired. The leakage past the outside packing is the same as in the forward end, namely, the small amount due to a pressure of only 3 pounds per square inch.

There are two main shaft bearings, one at each end of the casing. They are of the self aligning type, with water circulation in the brasses, and arranged for forced flow of oil. The oil, after passing through the bearings, is filtered and cooled and returned to the supply tank.

The main shaft is extended through the forward bearing to form the thrust bearing, which is of the ordinary horeshoe type.

The casing, main bearings, and thrust bearing are all carried by a structural foundation built up from the hull. The casing is built up of separate cast iron flanged sections, one for each stage, and all are divided in halves on the horizontal, so that the top can be removed for inspection. A continuous post is cast on each side of the casing and rests on a cast iron sole plate supported by the foundation. The forward end is rigidly fastened to the foundation, and expansion is provided for by allowing the after end to slide longitudinally on the foundation.

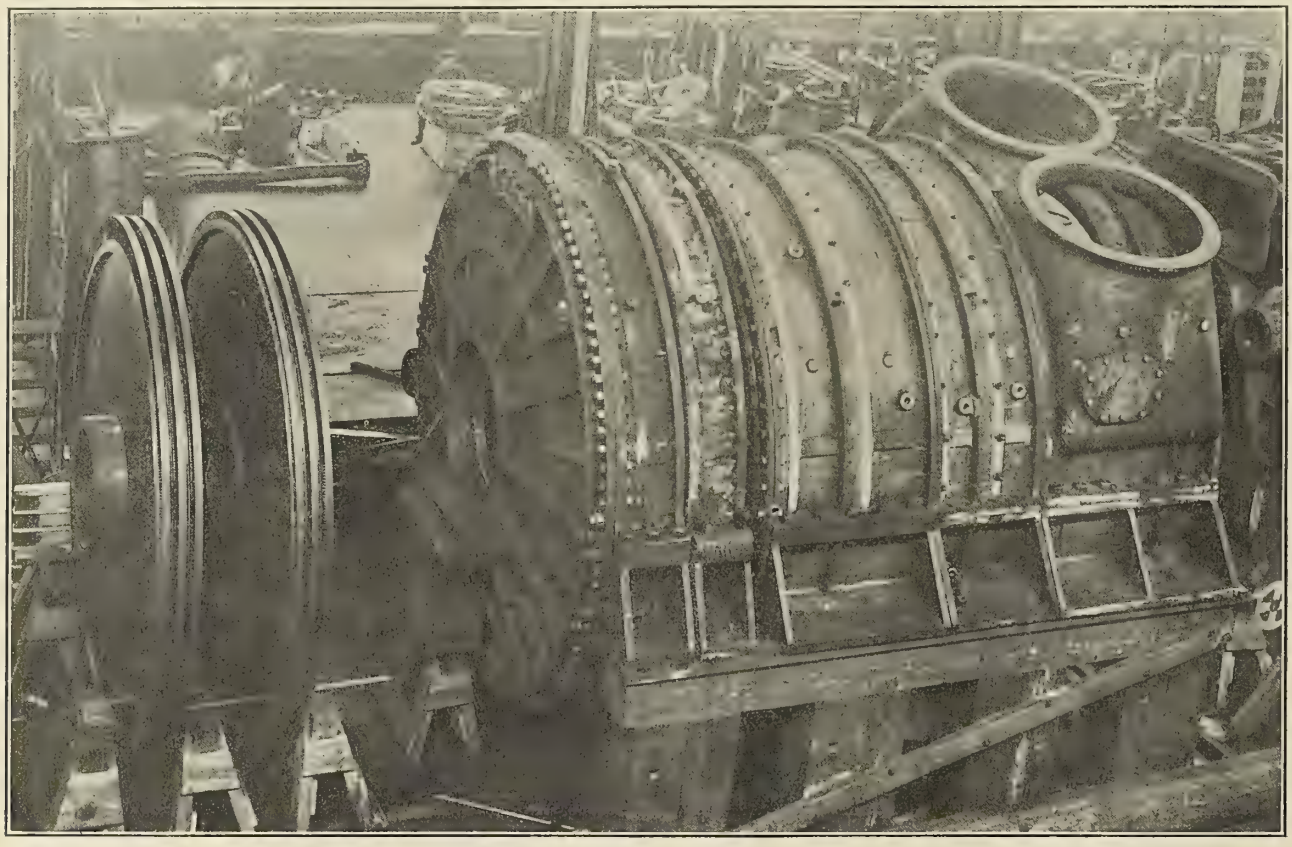
The axial clearance between the moving buckets and stationary guides in each stage is shown at all times by a small clearance indicator attached to the casing.

A fly ball governor driven by direct gearing to the reverse shaft operates a butterfly valve in the main steam. The governor is adjusted so that an increase of 10 percent above normal speed closes the valve.

A 5 by 5-inch double turning engine is provided, which operates through a worm wheel on the main shaft, and by means of a system of clutches can turn either turbine at will.

The method of blading is shown by the accompanying sketch.* The blades are made of extruded bronze; the process consisting of forcing the metal through steel dies. By this means the shape can be made very accurate and kept absolutely uniform; also a very smooth surface is produced, and the skin of the metal is made very tough. The sketch shows the shape of the section of the first row of revolving buckets and guide blades or intermediates on the first stage wheel.

The blades are held in place by casting them into a segmental base of section as shown. The ends of the blades enter about half an inch into the base casting, and the two metals fuse together and form practically one solid piece. The union is so perfect that when pulled in the testing machine the blade itself breaks instead of pulling out of the casting. The segment castings holding the revolving buckets are calked into the rims of the wheels, while those holding the intermediate guides are held by screws to the casing, as shown. Bronze strips of section as shown are riveted across the ends of all blades, thus supporting the outer ends and forming a closed passage for the steam.



THE OUTSIDE OF THE TURBINE CASING, AND SIX DISKS OF BLADES ON THE ROTORS.

The radial clearance can be as large as desired, without affecting the economy or operation of the machine, and is approximately half an inch. The axial clearance it is desirable to keep comparatively low. In the first row it is one-tenth of an inch, as shown, but in the later rows, where the pressure is less, it is increased to one-quarter inch.

The above solid construction and liberal clearances produce a machine that has small chance of accidental breakage. Of 400,000 horsepower of Curtis turbines in actual operation, not a case of blade stripping has ever occurred.

Not only is the design of this turbine patented, but the method of construction is similarly protected.

Propellers.—The propellers are 11 feet 6 inches in diameter, and have cast steel hubs and adjustable manganese bronze blades.

*See blade segments, page 386.

AUXILIARY MACHINERY.

Main Condensers.—Each main turbine exhausts direct into a cylindrical shell surface condenser having 10,000 square feet of cooling surface, made up of ¾-inch outside diameter, No. 17 B.W.G. brass tubes, tinned inside and outside. The shell is made of 5/16-inch steel plate, heads and doors of iron, tube heads and supporting plates of brass; screwed stuffing boxes and cord packing is used. Each condenser, as fitted with jet injection, weighs 55,000 pounds, and is guaranteed to condense 66,125 pounds of steam per hour at 27 inches vacuum, with sea water at 85 degrees F.

Main Air Pumps.—Each condenser is provided with one vertical, double acting, air pump 14 by 14 by 26 by 18 inches, simplex, which is guaranteed to produce 27 inches vacuum in the condenser under the specified conditions. The water ends are of semi-steel, with composition liners, pistons, rods, stuffing boxes, valve seats and fittings; steam cylinders are of cast iron. Weight 22,000 pounds each.

Main Circulating Pumps.—Each condenser is provided with one 20-inch horizontal, volute, centrifugal circulating pump, with inclosed composition impeller, composition shaft and self-ring-oiling bearings. The pump is directly connected to a 12 by 12-inch Reeves vertical simple engine operating at 290 revolutions per minute, when the pump is discharging 12,000 gallons of water per minute against a total head of 20 feet; under this condition an efficiency of 70 percent is guaranteed for the pump, and a steam consumption of the engine of 18½ pounds per indicated horsepower per hour condensing, and 22½ pounds non-condensing.

Auxiliary Condenser.—One auxiliary condenser with 12 by 14 by 16 by 16-inch horizontal single combined air and circulating pump is used. The condenser is mounted on top of pumps, and has a cylindrical wrought iron shell with 1,200 square feet of cooling surface. Total weight, 15,200 pounds.

Heaters.—A 60-inch "multi-coil" feed water heater is used, also two 6-inch Ebsen grease extractors, as made by the James Reilly Repair and Supply Company.

Pumps.—The following vertical, tandem compound, duplex pumps are used:

Main feed, 2, size 17 by 9 by 12 (not compound),
Donkey and fire, 2, size 8 and 14 by 6½ by 12,
Salt water sanitary, 1, size 5¼ and 7½ by 7 by 12,
Fresh water sanitary, 1, size 4 and 6 by 5 by 6.
Auxiliary sanitary, 1, size 5¼ by 5 by 6 (not compound),
Ballast pump, 1, size 8 and 12 by 12 by 12, horizontal.

STEAM GENERATING PLANT.

Main Boilers.—Ten Babcock & Wilcox marine type water tube boilers, each provided with a superheater, supply steam for all normal operation. They are designed for 250 pounds pressure and 100 degrees F. superheat, and have main tubes 4 inches in diameter, straight, and expanded into the regular Babcock & Wilcox sinuous headers. Superheater tubes are 2 inches in diameter, V-shaped and terminate in two straight parallel headers. The superheater is mounted on top of the boiler casing, and the baffles are so arranged that the hot gases pass through the superheater after their first passage across the tubes. After leaving the superheaters they pass twice across the main tubes. The boilers are arranged in one compartment, with two athwartship firing spaces; they operate under natural draft at all times.

Total grate surface, 770 square feet; heating surface, 28,500 square feet; ratio, 37.

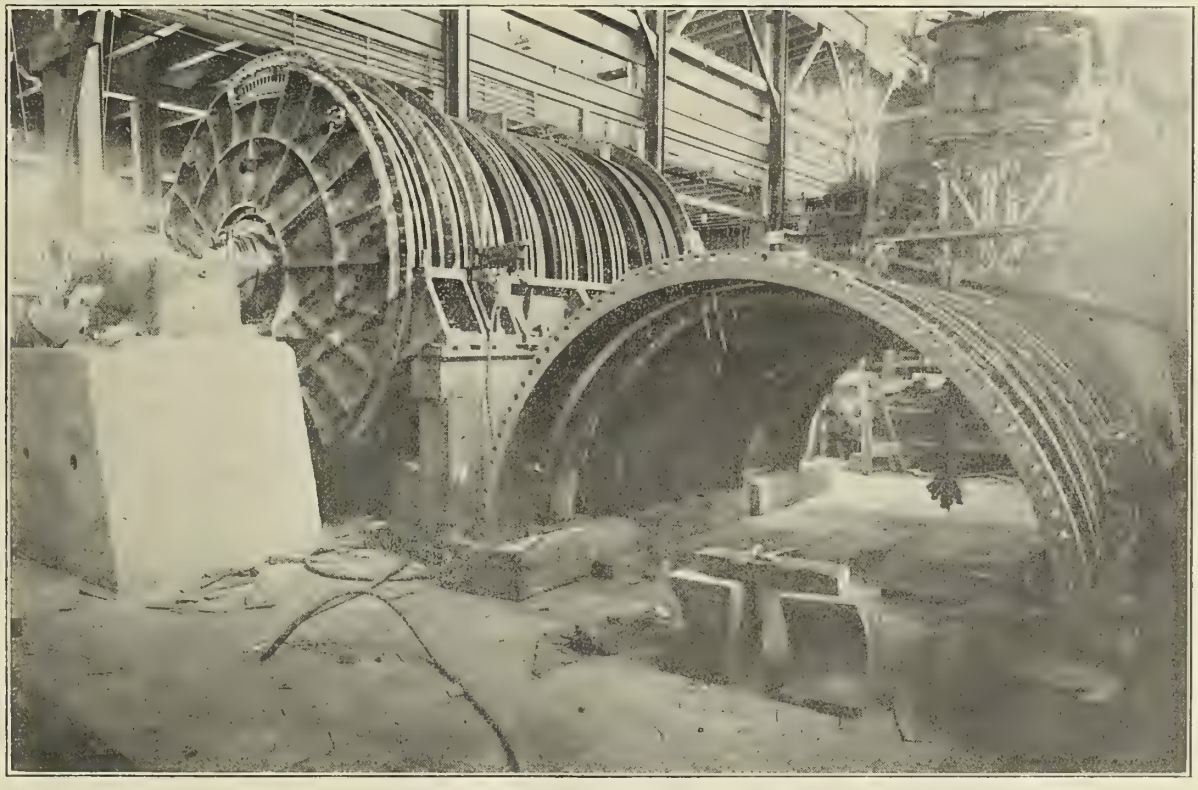
There are two elliptical funnels 15 feet 6 inches by 12 feet 6 inches, which rise 110 feet from the grates. To assist the fireroom ventilation there are four Sturtevant 55-inch steel plate fans driven by 3½ by 2½-inch double inclosed engines, each giving 4,000 cubic feet of air per minute at 660 revolutions per minute.

Two See 6-inch compound 60 degree ash ejectors are fitted in the firing spaces.

Steam Piping.—All steam piping is of seamless hot-drawn steel tubing with steel flanges. A 9½-inch diameter main steam pipe runs forward from each turbine, and has 4½-inch diameter branches to five boilers on one side of the vessel; a cross branch is run in the engine room, so that any combination can be used. The branches from the main steam pipe to each boiler run to one flange of the cross stop valve, the other flange being connected to one end of the superheater through a globe valve. The other end of the superheater is connected to the angle stop valve of the boiler. This arrangement allows steam to be taken direct from the boiler or through the superheater.

A 6-inch auxiliary steam pipe has branches to four of the boilers, in order to allow any of these boilers to supply steam for use on the auxiliary machinery. The auxiliary steam runs at 150 pounds pressure.

Donkey Boiler.—A horizontal internally fired donkey boiler is located in the upper 'tween decks. The shell is of ½-inch plate, 75 inches diameter and 12 feet 9 inches long, with 40-inch Morison corrugated furnace, and 166 tubes 2¼ inches in diameter, leading from the combustion chamber to the forward end. The heating surface is 573 square feet, and grate surface 14.16 square feet.



COMPLETED ROTOR ON SHAFT, WITH CASING ENDS IN PLACE. UPPER HALF OF CASING AT RIGHT.

ELECTRIC INSTALLATION.

The generating plant consists of two 75-kilowatt General Electric direct connected Curtis turbine generating sets and one 10-kilowatt engine driven set. They will operate at 110 volts direct current. The plant is located in the propelling engine room.

The distribution is on the two wire system, feeders from the generator board supplying numerous panel boards in cabinets located in various parts of the vessel; each panel board supplies the lights in its immediate vicinity on comparatively short distribution circuits. Steamtight fixtures with wiring in galvanized iron conduit used in all machinery spaces, freight spaces and hold. Living spaces are wired in molding, and have suitable fixtures to harmonize with the surrounding decorations. A total of about 860 incandescents will be used.

Electric heaters are installed in all the first and second cabin staterooms and officers' rooms amidships. These heaters are on circuits fed from the main switchboard independently of the lighting system. They are of the General Electric make.

Marine type, needle drop annunciators are installed, with wiring

in molding and pushbuttons in staterooms, and an automatic fire alarm system in conduit is fitted in the holds.

There is fitted an elaborate system of mechanical engine telegraphs, steering telegraphs and anchor, sounding and docking telegraphs, in the pilot house, and on the navigating bridge forward, and the warping bridge aft, together with voice pipes and voice pipe calling apparatus. The pilot house is equipped with a running light indicator, and electric shaft revolution indicators.

Electric bracket fans, direct connected exhaust fans, an electric dish washing machine, an automatic electric whistle operator and a 24-inch searchlight comprise the balance of the vessel's electric equipment.

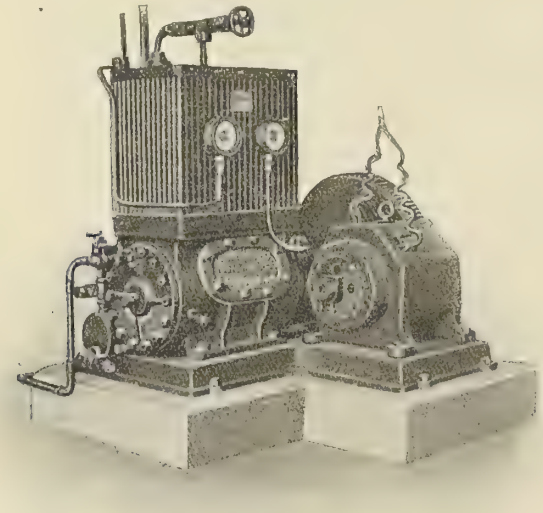
COLD STORAGE ON BOARD SHIP.

PART IV.

BY SYDNEY F. WALKER, M. I. E. E.

LEADING THE COOLED AIR INTO THE COLD CHAMBER.

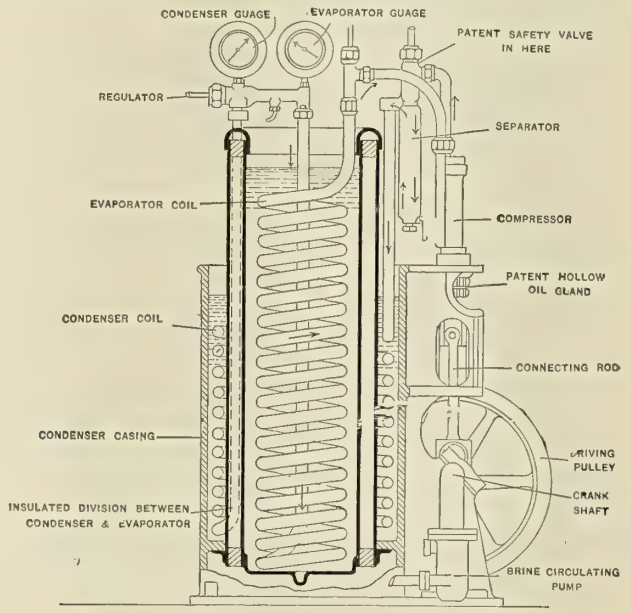
There is one method of accomplishing this in all cases—by wooden ducts connecting the cooling chamber with the air chamber. These may be very large, where the air is cooled merely by the aid of a refrigerant—large enough for a man to walk in—and will contain ports opening into the cold chamber, fixed in positions where their opening will direct the current of air on to and over the surface of the produce to be cooled. The manipulation of the ports for regulating the air furnishes one reason for making the ducts large. Another and perhaps more important reason is the lessening of friction, and of power expended. Air, like brine and other fluids, rubs on the surface of the pipe or duct through which it is passing, and in rubbing sets up friction in proportion to the total rubbing surface, and to the square of the velocity at which it is traveling. Increasing the size of the ducts adds to the rubbing surface for a given length, but it also decreases the velocity of the air, and the gain by the latter is very much greater than the loss from the increased rubbing surface. Further, where produce is carried it is very important that dust and other objectionable matter shall not pass into the chamber, and this can be assured only by so arranging the ducts that they can be kept clean.



ENOCK 1¼-TON INCLOSED TYPE MOTOR-DRIVEN MACHINE.

The velocity at which the air passes over the surface of the produce has an important bearing upon preservation. Where the temperature does not matter, so long as it is below a certain figure, an air current at a high velocity will make no difference, but where the produce has to be maintained at a certain temperature, it has a great effect. When cooling by air, a certain quantity of air per hour must be passed through the cold chamber at a certain temperature. If the ducts are small, the air must pass through them at a higher velocity than when they are large, and it will issue into the cold chamber at a comparatively high velocity, with the result that the produce in the immediate neighborhood of the inlet ports will be exposed to great—possibly injurious—cooling effects, while that at a distance will receive only a much smaller relative effect. It is the same thing as with the drafts from which we catch cold. A draft is merely a current of air passing over our bodies or portions of them at a higher velocity than is good for us. Every cubic inch of air that passes over us extracts a certain number of heat units from our bodies, and principally from the part over which it passes. If these heat units are taken out rapidly the temperature of the body is lowered, particularly at the spot exposed to the draft, and congestion results. Similar results occur with produce.

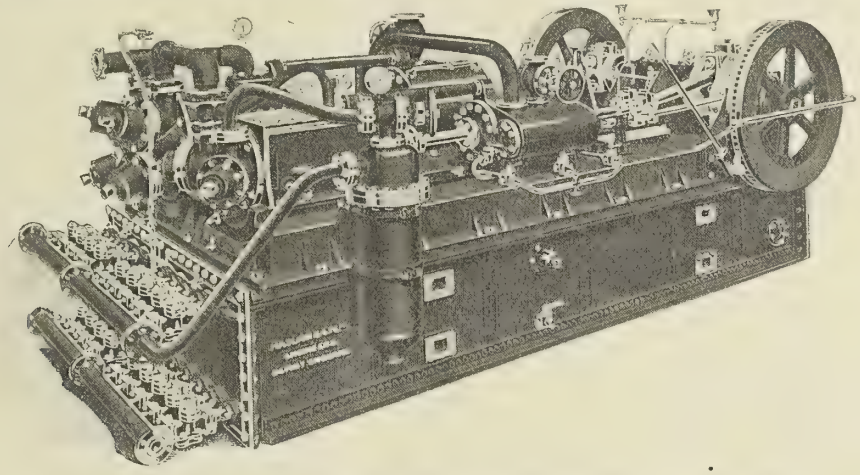
The air ducts for ship work are practically passages surrounding the cold chambers, somewhat on the lines of the wing passages which used to surround the old wooden ships below the water line, along which a man could walk right around the ship, to stop shot holes, leaks, etc. They should form complete circuits for the passage of the air from the cooling grid and back to it again, with doors arranged to connect them to the cooling chamber and the atmosphere. With compressed air cooling, even where it is on a comparatively large scale, there is not much room for ducts, both because warming of the cooled air would take place largely in the ducts, and because of the friction mentioned above. The air cooled by compression and expansion is led to the cold chamber by the shortest possible route, the air duct being thoroughly well insulated. The use of the large air ducts described has the disadvantage that they absorb a good deal of room that could otherwise be filled with cargo, but the arrangement is much the best for certain classes of produce, such as fruit.



SECTION OF HALL CARBONIC-ACID COMBINED MACHINE.

Where the cooled air system is employed with two or more substances, having odors of their own, the ducts leading to the different chambers must not be allowed to connect in any way. The inlets of one must not be near the outlets of the other, and

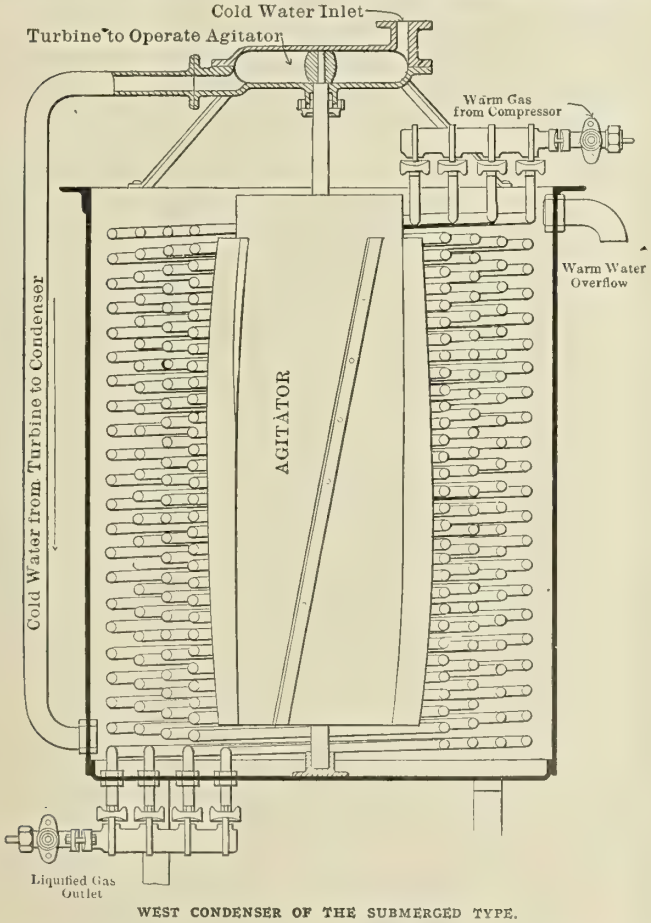
separate cooling apparatus and separate fans must be used, if the air returns from the chambers to the cooling plant. The case may be met by the adoption of what electricians would call the parallel system. One supply of air could be employed, and one cooling plant, and one fan, the air for the different chambers being directed into separate ducts and then discharged into the atmosphere from the chambers; but care must be taken, if this plan is adopted, that the air which passes out of the chambers does not get to the shaft from which the inlet air is taken.



HASLAM AMMONIA MARINE REFRIGERATOR, WITH COMPOUND ENGINE AND COMPRESSORS.

THE DOORS OF COLD CHAMBERS.

The doors of cold chambers are very important. They must be constructed on the same lines as the chambers themselves.



WEST CONDENSER OF THE SUBMERGED TYPE.

When a door is closed it must form part of the wall of the chamber into which it fits, in the sense that it excludes the heat, just as much as the chamber wall proper does. In ship work the difficulty is, as with so many other things, to find room for proper doors. The thickness of the doors should be the same as that of the walls; and as far as practicable, they should be built in the same way, of two lots of matched boarding, facing each other, lined with waterproof paper on their inside faces, and the space filled with an insulating material. The door itself also must be made to fit air tight into the doorway. There must be no cracks, such as we are accustomed to in the doors of our living rooms, and no spaces between the door and the wall, when the door is closed. Further, the door must be pressed home firmly when closed, and the fastening be such that it cannot easily work loose, even in a heavy seaway.

When the cold chamber is in use the door should be opened as infrequently as possible, and then closed immediately; for every time a door is opened, as already explained, heat is admitted to the chamber, which means more work for the machines. On shore, wherever it can be arranged, double doors are fixed, the outer being closed before the inner is opened, so that only the small lobby full of air from outside is admitted.

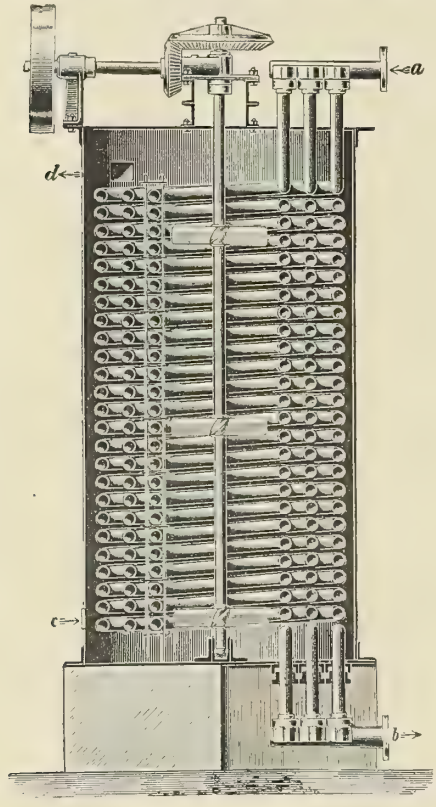
HOW THE LOW TEMPERATURE OF THE BRINE OR REFRIGERANT IS PRODUCED.

The operation of one method, that of alternately compressing air and allowing it to expand, has been described. The other method, of which there are two variations, has been partly indicated. A refrigerant, ammonia, carbonic acid or sulphurous acid, these solutions lending themselves peculiarly to this work, is caused to assume alternately the liquid state, and the gaseous state. In expanding from a liquid to a gas, it abstracts heat from the brine, the air of the chamber, etc., as has been shown. To accomplish this, and to work economically, a circuit is formed, consisting of the compressor or its equivalent, as will be described, the condenser, the expansion coils, and the connecting pipes. The compressor is practically a pump. After the refrigerant has done its work, and become a gas, it is sucked back into the compression cylinder, compressed, and then forced into the condenser, passing thence to the expansion coils and back to the compressor.

The latter consists of one or more cylinders in which pistons work, very much on the lines of steam cylinders, but with certain modifications. There are one or more suction valves to each compressor, and one or more delivery valves. The cylinders may be either single or double acting. If single acting, gas is taken in on one stroke and compressed on the return stroke, something on the lines of the old Cornish single acting engine, but with the operation reversed. When double acting, gas is taken in at each stroke, and compressed at each stroke, the rear of the piston performing the office of suction, while the front compresses. The valves are all of one type, shaped like the frustum of a cone, seated in extensions of the cylinder covers and kept

on their seats by spiral springs, which allow them to open inwards or outwards, as the pressure is reduced or increased sufficiently to allow the spring to operate in the case of the suction valve, and to overcome the spring in the case of the delivery valve. The piston also is slightly different from the ordinary steam or compressed air piston.

Marine engineers are well acquainted with the evils of clearance in engine cylinders. With compressors used for refrigerating apparatus the trouble is very much increased, because the small quantity of the gas remaining in the cylinder, in the clearance space, is in a highly compressed form, and immediately it is released by the return of the piston, expands, occupying the space left vacant, and introducing a pressure against the ingress of the next lot of gas, thus reducing the quantity taken in on the suction stroke. To obviate this, nearly all compressors are made with the ends of the cylinders dome shaped, and the ends of the pistons hemispherical, or as nearly so as they can be made, so that they run very close up to the cylinder end. One firm in



SUBMERGED CONDENSER.

a AMMONIA INLET. *c* WATER INLET.
b. AMMONIA OUTLET. *d*. WATER OUTLET.

the United Kingdom uses a flat cylinder end, a flat piston, and provides a spring which is compressed as the piston moves up to the cylinder end, the spring taking the thrust, keeping the piston away from the end of the cylinder, and helping to start it back on the return stroke.

The De La Vergne Company of New York employs another method. A small quantity of oil is injected into the cylinder, shortly before the end of the stroke, and the oil and gas are ejected together, the refrigerant being freed from the oil by a separator before being used again. The delivery valves open automatically when the pressure inside the cylinder on the compression side of the piston is sufficient to overcome the tension of the spiral spring, and close immediately when the pressure is reduced sufficiently for the spring to overcome it; the suction valve doing the same, in the reverse direction.

Compressors for refrigerating machines are often made compound. The compression is completed in two cylinders, there being sometimes an intercooler between the two. The gas is compressed to a certain pressure in one cylinder, and the complete pressure obtained in the second. It is the reverse operation to that of a compound engine. In the act of compression the gas is made to take up a smaller volume, and becomes heated, just as air does in compression. It is necessary to compress the gas in order to enable it to be liquefied with a reasonable quantity of cooling water. The molecules of the gas are brought closer together, and are then more ready to take on the liquid form. But in order that the gas may become a liquid, the heat of compression, as well as the latent heat of the gas, must be removed. Further, as it becomes heated it tends to expand, and to occupy a greater space than it would otherwise do, and than it will do when the heat is removed. It is for this reason that the intercooler, where compound compression rules, is so valuable. By removing the heat of compression of the first cylinder, the volume entering the second cylinder is smaller for the work that is to be accomplished. Besides, the heat generated would otherwise act upon the cylinder itself, and if allowed to become too great, upon the valves.

When the compression cylinder is hot the gas entering at the suction stroke is heated and expands, and the weight that is taken in at each stroke is lessened, so that the efficiency of the apparatus is thereby reduced, for more work has to be done by the compressor for the same refrigerating effect. There are several methods of dealing with this matter. One has already been referred to, that of the De La Vergne Company. The oil which is injected into the cylinder to fill the clearance space also cools the cylinder itself, by absorbing some of the heat. Another method is what is termed the "wet compression." A small quantity of liquid refrigerant is allowed to pass into the compressor, with the gas. On its entrance into the cylinder, it expands to the gaseous state, absorbing some of the heat of the cylinder walls, etc. One objection to this is that it is difficult to arrange it properly, and its effective operation must depend upon the attendant.

The cooling is effected in the expansion coils by the passage of sufficient liquid refrigerant into them, to absorb the heat that is to be taken away. Any additional quantity of liquid refrigerant that is allowed to pass through lowers the efficiency of the machine, as it has to be handled without giving back any useful result. On the other hand, cooling the cylinder by the aid of the refrigerant adds to the efficiency. It is again a case of the balance sheet. Another method is the well-known one employed with gas engines, of circulating cooling water in a cylinder jacket. Double acting compressors heat more than single acting, as will be easily understood, and for that reason many engineers prefer single acting apparatus.

(*To be continued.*)

THE NEW TRAFALGAR GRAVING DOCK AT SOUTHAMPTON.

Southampton is in course of becoming one of the most important ports of England. In 1892 the tonnage entering this port was 2,369,642 tons gross, while in 1904 this tonnage increased to 5,693,642 tons gross, and this year will be more important, as now a very large part of the American import and export trade passes through Southampton, which has for speedy loading and discharge of vessels every appliance necessary to make it a first-class port.

In the beginning of 1901, after having just opened a fifth dock, the London & Southwestern Railway decided on the construction of a sixth capable of receiving the largest vessels in the world. This dock was commenced in August of the same year, and was opened on October 21 last. Its cost was about $1,500,000, equipment included, and all three dimensions taken into consideration, it may be reckoned as the greatest in the United Kingdom.

Its main dimensions are:

Length from joint of sill to dock-head..... 875 ft., 3 in.
Length occupied by keel-blocks..... 839 ft.

Width of entrance	90 ft.
Width of dock at floor level	90 ft.
Width of dock at cope level	125 ft.
Depth of dock from cope to floor	43 ft.
Depth of water over sill at high water of ordinary spring tides	33 ft.
Depth of water over sill at high water of neap tides	29 ft., 6 in.
Depth of water over keel-blocks	6 in. more than over sill.

The dock has been constructed on made land; the area has been inclosed with a chalk dam, and chalk was utilized in foundation work. The excavation for the dock involved the removal of 226,200 cubic yards of material. Some 133,000 cubic yards of Portland cement concrete have been used for the floor, altars and walls, which are entirely built of this material. The bottom of the dock is curved, the maximum thickness being, of course, at the center, where the upward thrust will be the greatest. Here, it is 16 feet thick. The side walls are 22 feet 6 inches at the base, diminishing to 3 feet at the coping. There are seven altars, 2 feet 6 inches wide and 2 feet 9 inches high. Access to the bottom of the dock is afforded by eight flights of steps, while there are four timber slides. The keel-blocks are all of oak with elm caps. The sill is formed of granite, and the gates have been constructed entirely of steel. The entrance gates are covered by greenheart timber meeting faces, and 250 tons of steel are contained in each gate. The gates are opened and closed by direct-acting hydraulic rams, operating through a suitable crosshead, and a build-up lever attached to the rear of the gate. When opened, they lie in a recess formed in the entrance walls, with timber fenders.

The powerhouse for the dock is a very capacious building, including, in the center, the steam generating plant, at the upper end the electric machinery for running the motors and lamps throughout the whole dock estate, and at the lower end the pumping plant, including two 48-inch pumps, driven by powerful two-cylinder engines. There is a large condenser for these and the electric generating engines. Separate auxiliary machinery, consisting of airpumps and circulating pumps, is installed. It is anticipated that the main pumps will discharge the water from the dock (85,000 tons) in about 2½ hours. There is further a 12-inch centrifugal pump for dealing with any water that may leak into the dock from time to time. The steam plant consists of seven locomotive boilers. These are sufficient to run the electric lighting plant as well as the main pumps. There are six sets of compound inclosed high-speed engines, driving 75-K. W. generators. The distribution is on the three-wire system. Included in the equipment of the dock is a very powerful electric crane, shown in our illustration, which has a capacity of 50 tons at a radius of 87 feet, or at the center line of any ship in the dock, and which travels the whole length of one side of the dock.

E. O.

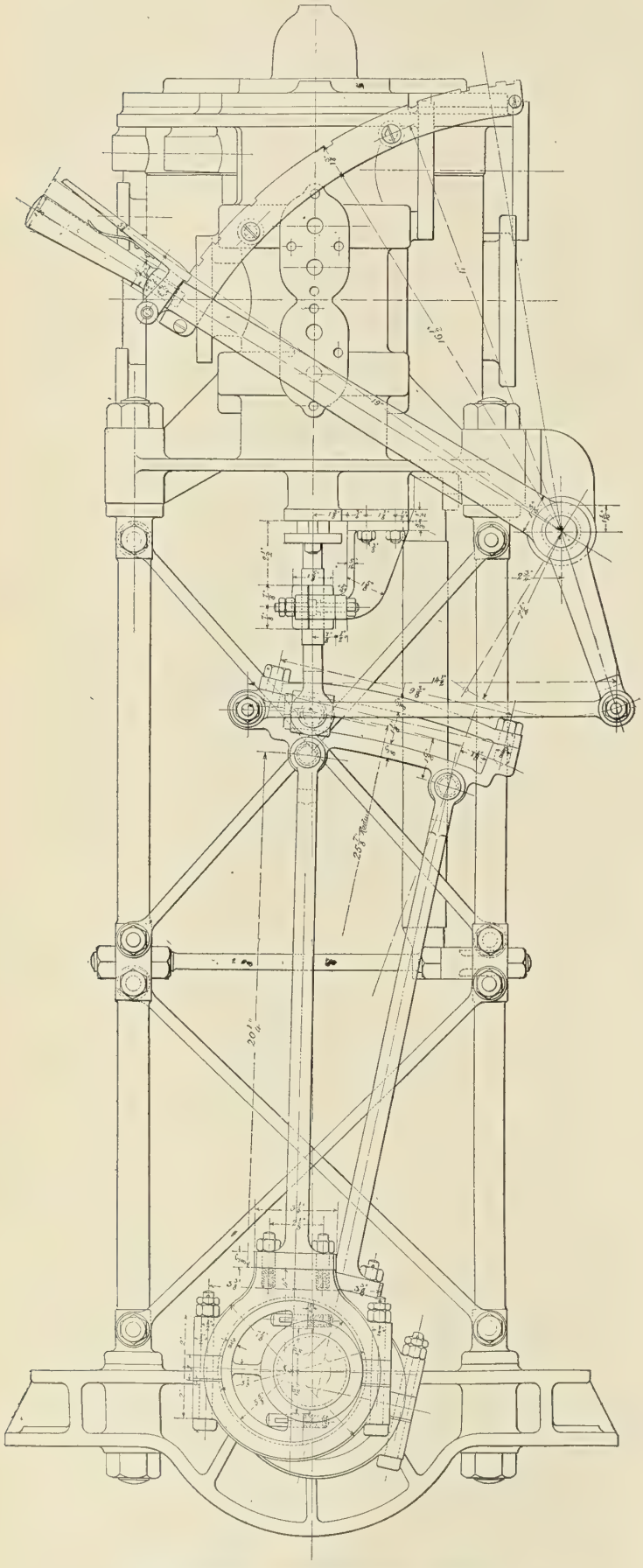
A VIEW OF THE TRAFALGAR DOCK, EMPTY OF WATER, SHOWING FIXED KEEL BLOCKS.

A COMPOUND ENGINE DESIGN.

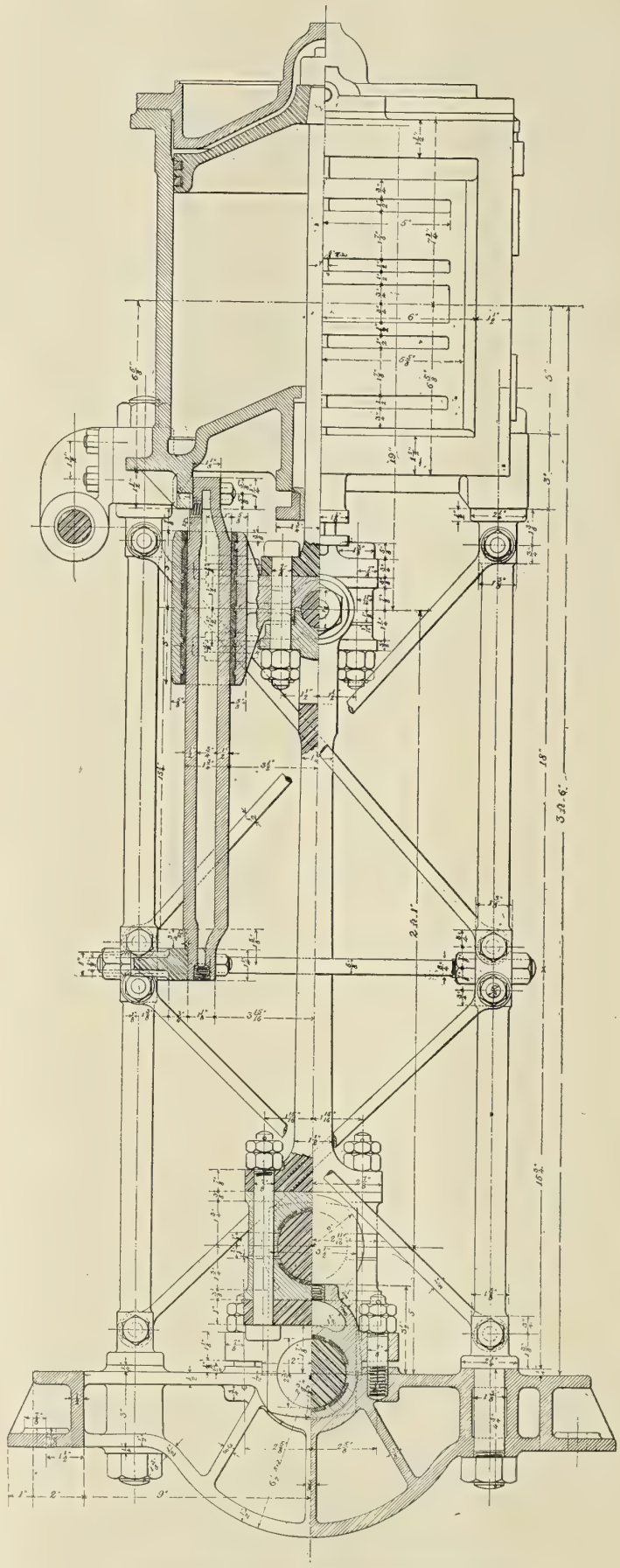
Numerous requests have reached us for specific information regarding the design of marine engines of various sizes and characters. We are enabled to present in this issue drawings of such an engine design, by Henry J. Gielow, the drawings showing a great deal of detail, and being, in fact, actually working drawings from which the engine was constructed.

This engine was built for the Quartermaster's Department of the United States Army, about a year and a half ago, being fitted in a steamer measuring 60 feet 6 inches on deck, 53 feet 3 inches on the load line, with a beam of 12 feet 2 inches, a molded depth of 6 feet 6 inches and a load draft of 4 feet 3 inches. The engine was designed to develop about 100 horsepower, corresponding with a speed of 12.5 statute miles per hour. Both power and speed were exceeded on trial, the engine having been worked up to 125 horsepower, while the most efficient operation appeared to have been at about 80 horsepower.

As shown on the drawings, the engine is compound, with cylinders 6 and 12 inches in diameter and a common stroke of 10 inches. The high-pressure cylinder is fitted with a piston valve 3¾ inches in diameter, while the admission and discharge of steam from the low-pressure cylinder are governed by a double ported D slide valve. The steam port on the high-pressure cylinder has an area of 4.38 square inches, and exhaust port 4.9 square inches; on the low-pressure cylinder these areas are respectively 9.5 and 11 square inches. The cylinder barrels have a thickness of ⅝ inch, and are made of close grained cast iron, bored and with a counterbore of 3-32 inch at each end. The lower



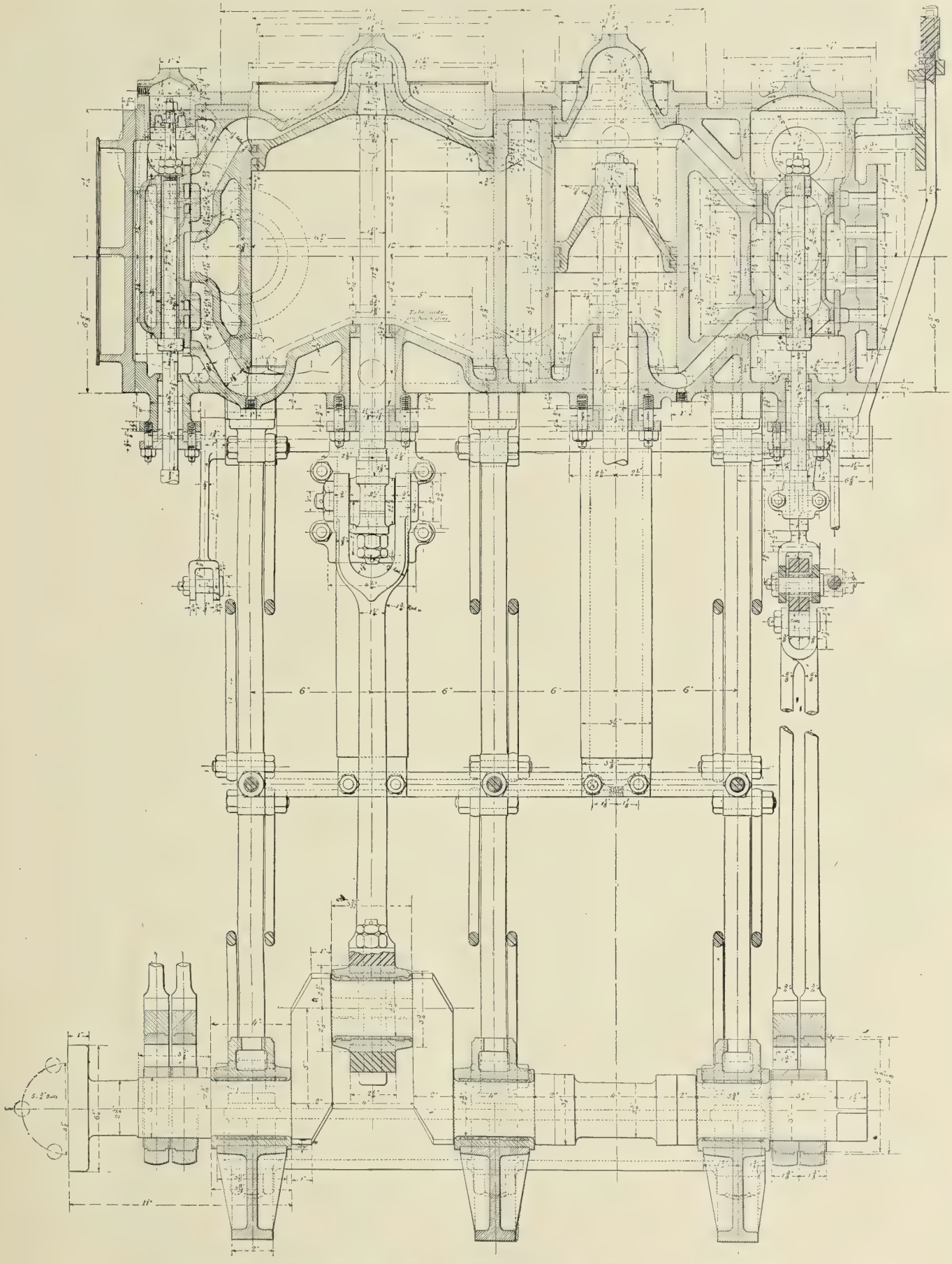
END ELEVATION OF ENGINE, FROM FORWARD.



PARTIAL SECTION OF LOW PRESSURE CYLINDER.

heads are fitted with stuffing box and gland with metallic packing, while the upper heads are conical, with central hoods to accommodate piston nuts.

The main frame of the engine consists, as shown, of six steel columns 1¼ inches in diameter, with three transverse tie rods ⅝ inch in diameter and two longitudinal ties of T section.



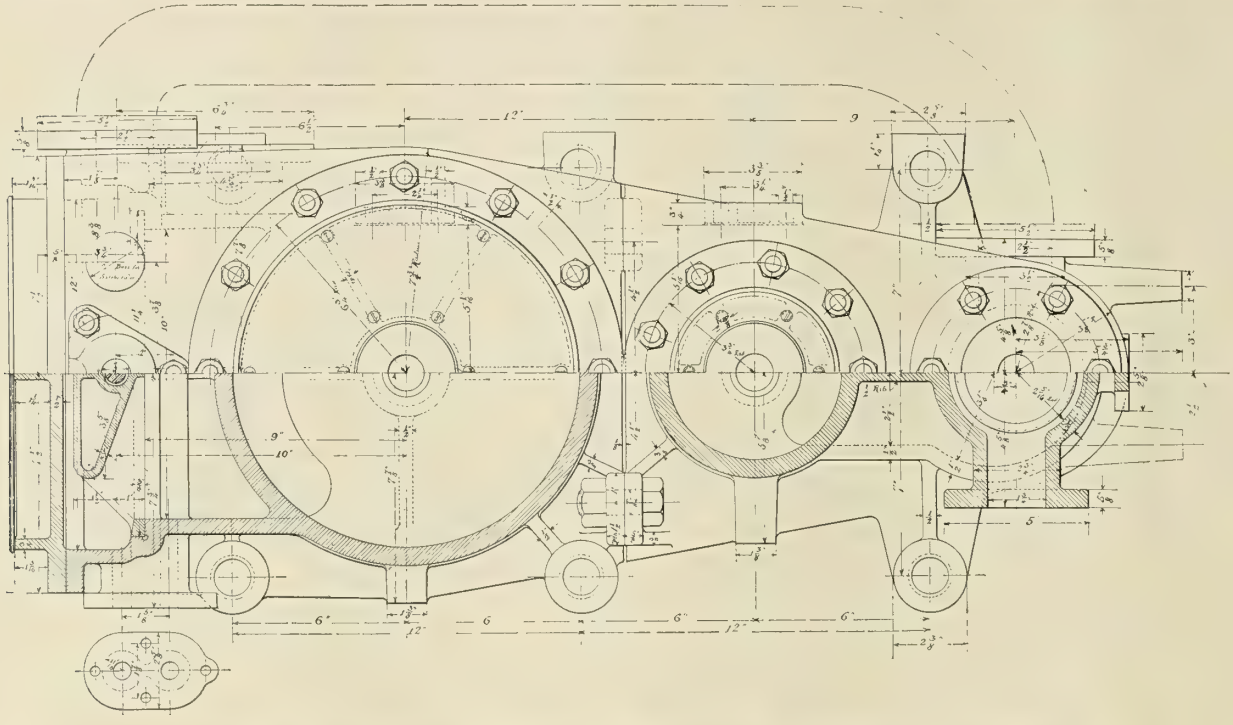
LONGITUDINAL SECTION OF THE ENGINE, SHOWING THE VALVE ARRANGEMENT AND DETAILS.

There are also twelve diagonal braces, ½ inch in diameter, fitted as shown on the drawings.

The valves are worked by Stephenson link motion, with single bar links having a throw of about 6 inches, there being two

eccentrics to each link. The eccentric rods are of forged steel, the ends connecting with the straps having a T head forged on to bolt to straps. The link ends of rods are forked for connection with the link. Eccentric straps are of composition.

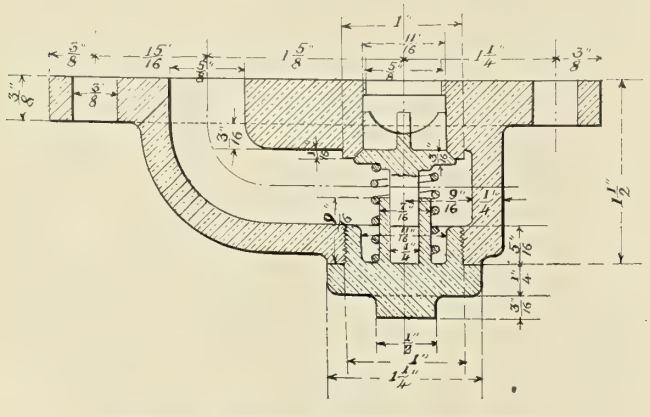
angle of 90 degrees; crank arms have a thickness of 2 inches and width of 3½ inches; crank pins are 4 inches long and 2¾ inches in diameter; main bearings have a diameter of 2¾ inches, and a length of 3⅝ inches for the forward journal and 4 inches for



PLAN VIEW OF ENGINE, HALF IN SECTION, SHOWING COMPACT ARRANGEMENT OF CYLINDERS.

The pistons are single shell, of cast steel, and fitted with hard cast iron packing rings with customary tongue piece. Piston rods are forged steel, 1¼ inches in diameter, with taper fit to piston and forged T ends for crosshead connection. They are secured to pistons with steel nuts and pins, and to crossheads with steel bolts and nuts.

The crossheads are made of bronze in two pieces bolted together, each having a journal 1½ inches in diameter and 2¼



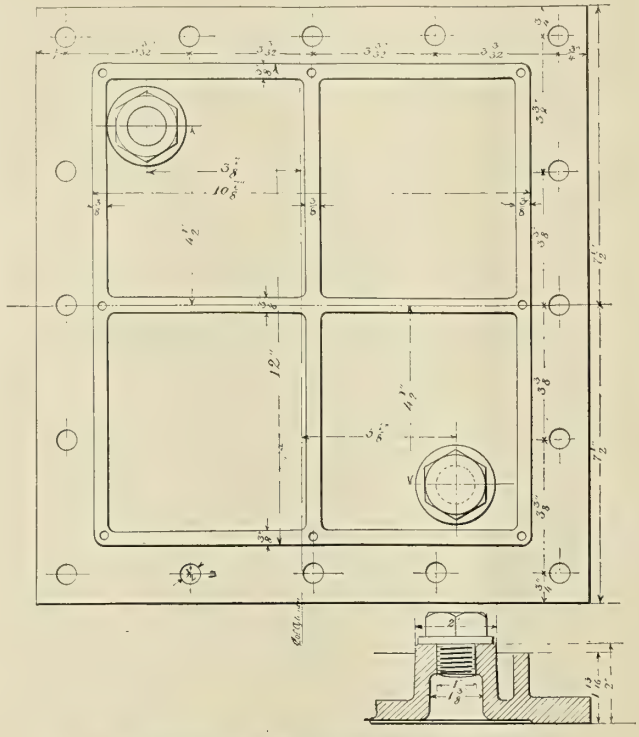
SECTION OF THE HIGH PRESSURE RELIEF VALVE.

inches long. The wearing surfaces of crosshead slippers are about 21 square inches each. Crosshead guides are of box section, of hard cast iron, with face 3½ inches in width and 1¾ inches thick.

The connecting rods are of forged steel forked at the crosshead end, and fitted with T at crank end. They are about 25 inches long between centers, and furnished with composition boxes around the crank pins. The rods have a diameter of 1¼ inches at the upper end and 1½ inches at lower.

The crank shaft is of forged steel, with two cranks set at an

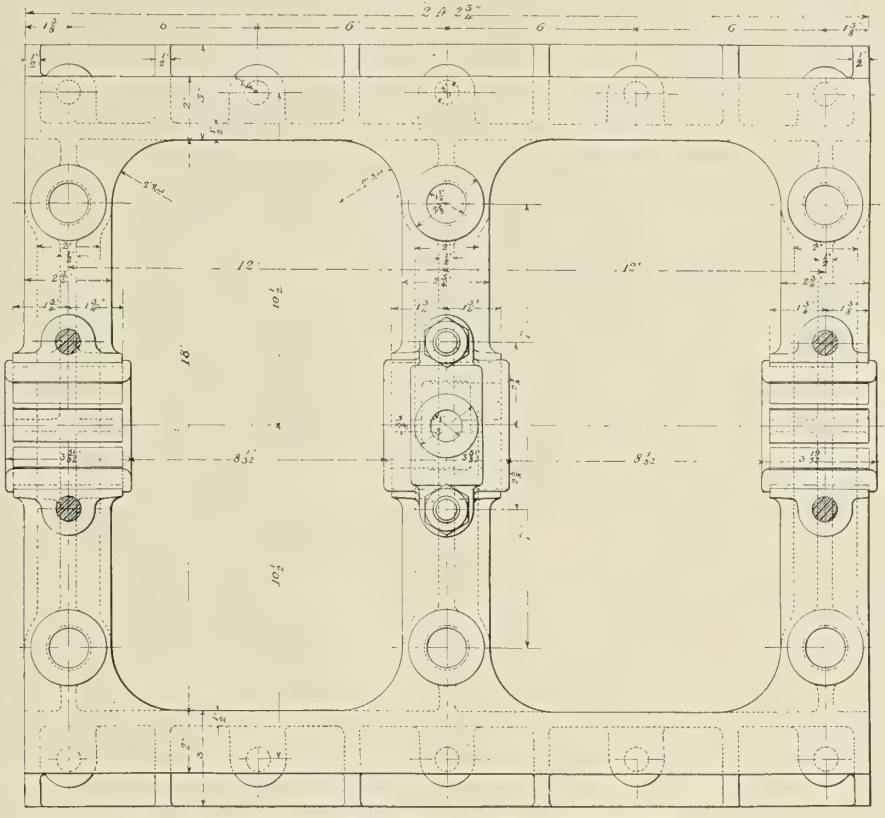
each of the others. The crank shaft pillow blocks have caps of bronze, lined with white metal, and held in position by six steel ⅞-inch bolts, two in each bearing.



LOW PRESSURE VALVE CHEST COVER AND DETAIL.

The line shaft is made in two lengths, the forward section, or thrust shaft, being of forged steel 2¾ inches in diameter,

while the after section, or tail shaft, is of tobin bronze 3 inches in diameter. The couplings are forged on the shafts, disks being fastened together with six ⅞-inch steel bolts. The disks have a diameter of 6¼ inches. The tail shaft has a length of 9 feet



BED PLATE OF ENGINE, SHOWING THE THREE MAIN BEARINGS.

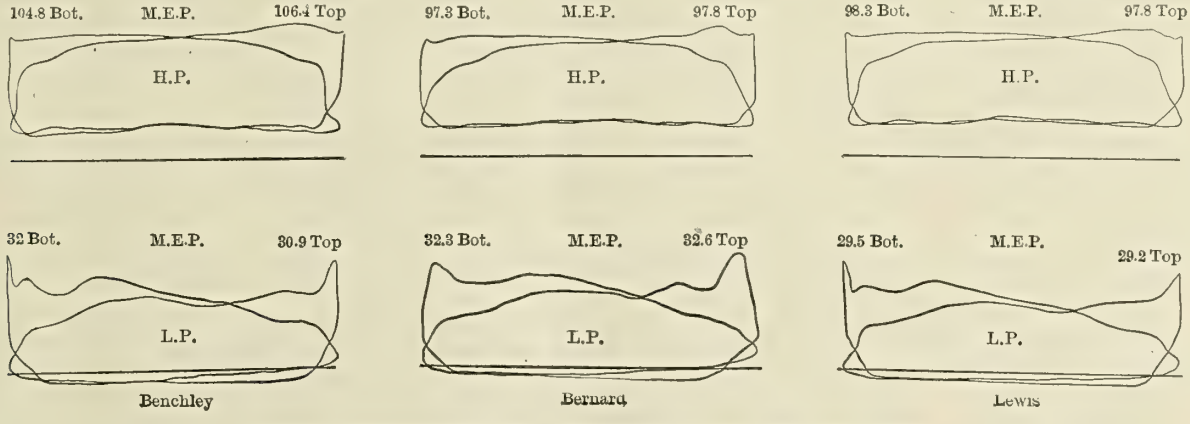
6 inches, and the thrust shaft of 7 feet. The thrust bearing is near the forward end of line shaft, and is of the usual collar type, with proper connection to the oil reservoir for lubrication.

Steam is furnished by a water tube boiler 5 feet 6 inches long, 5 feet wide and 5 feet 4 inches high, with a grate surface of 17.4 square feet and a heating surface of 515 square feet.

made unduly heavy. The operation is reported to have been very smooth in every respect, and the engine appears to represent an extremely "healthy" type of engine for the power required.

TRIAL

Three of these engines were fitted respectively on the United States steamers *Lieutenant Lewis, Lieutenant Bernard* and *Lieutenant Benchley.* We have been given indicator cards from these three steamers, together with data covering the tests, and

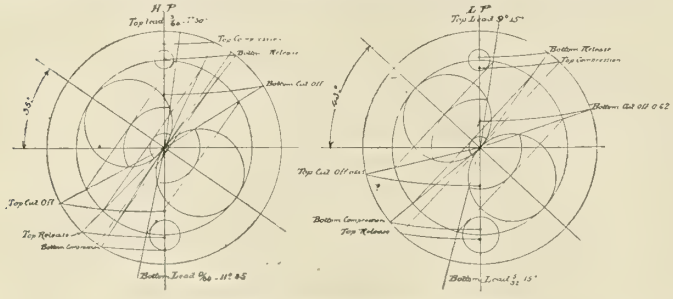


SAMPLE INDICATOR CARDS FROM THREE ENGINES BUILT FROM THIS DESIGN.

The designed working pressure of the engine was 250 pounds, although it was expected that operation would be usually at 175 pounds per square inch. All of the parts, however, were proportioned for the higher pressure. This engine, having been built for steady and heavy service under Government specifications, has shown itself thoroughly well adapted to the work which it has been called upon to perform, there having been no attempt to cut the weight below the figure which would give ample strength for all purposes, and on the other hand no part is

are informed by the Quartermaster General of the War Department that on each of the trials the engines ran smoothly and without heating in any of the bearings, although driven to maximum speed for over four consecutive hours with valves in full gear, throttle wide open and boiler at full pressure. Each launch has a three-bladed propeller consisting of solid casting of composition and having a diameter of 42 inches, pitch 48 inches, developed area 698 square inches, projected area 556 square inches. The disk ratio, or ratio between projected area and the area of

the circle swept by the tips of the blades is 0.402. A pitch ratio of 1.14 results from the relation between diameter and pitch.



VALVE DIAGRAMS, HIGH AND LOW PRESSURE.

	Benchley	Bernard	Lewis
Steam pressure	178lb	175lb	171lb
Receiver pressure	40lb	43lb	43lb
Vacuum, inches	15.25	16	14.75
M. E. P., H. P. cylinder	105.6	97.55	98.05
L. P. "	31.45	32.45	29.35
I. H. P., H. P. "	52.3	47.	48.5
L. P. "	63.4	63.6	59.
main engine	115.7	110.6	107.5
auxiliaries	8.	8.	8.
Revolutions per min.	355.	345.	354.
Miles per hour	(*a*) 13.45	(*b*) 12.	(*b*) 11.84
Pounds coal per hour	185	185	170

a With the tide. *b* After eliminating current.

STEAMING ECONOMY OF U. S. S. MARYLAND.

BY H. C. DINGER, U. S. N.

The *Maryland* is a large armored cruiser of 14,000 tons displacement; designed horsepower 23,000, speed 22 knots; horsepower developed in service 27,500, speed 22.5 knots. Her installation of machinery consists of two sets of four-cylinder triple expansion engines, with cylinders 38½, 63½ and two of 74 inches diameter, all with a stroke of 48 inches. All cylinders are steam jacketed. The low-pressure cylinders are at the ends, with the high and intermediate in between. All valves are of the piston type. There are sixteen Babcock and Wilcox watertube boilers, safety valves set at 285 pounds, total grate surface 1,600 square feet. Feed water heaters which use the auxiliary exhaust steam as the heating agent, are installed, one in each engine room.

The installation may be taken to represent the latest practice with reciprocating engines, and hence the economy obtained under various conditions may be of particular interest. The following are some results obtained in practice:

Boilers.	Revs.	I.H.P.	Speed.	Coal per I.H.P.	Coal per day
16 Nat.	106.5	15,395	19	1.74	(a) 288 tons
6 F. D.	95.5	10,520	17	1.74	(a) 183 "
10 Nat.	90	8,444	16	1.71	(a) 155 "
8 Nat.	82	6,736	15	2.08	(b) 50 "
6 Nat.	74	5,422	14	1.95	(c) 114 "
6 Nat.	64	3,152	12	2.3	(c) 79 "
4 Nat.	62	3,232	11.2	2.04	(a) 71 "
4 Nat.	56	2,634	9.5	2.32	(a) 65 "
16 F. D.	127.5	27,102	22.5	2.3	(b) 669 "
16 F. D.	127.8	27,571	22.4	2.95	869 "

(a) New River, (b) George's Creek, (c) Eureka.

The figure "coal per I. H. P." given above is obtained by dividing the total number of pounds of coal burnt for all purposes, including lighting, distilling, etc., by the I. H. P. of the main engines. By taking away the amount of coal used for auxiliaries, and then dividing by the horsepower of main engines, results below 1.6 have been obtained when running at 84 revolutions. The last line gives the figures of coal consumption on the official trial trip.

While in company with other ships of her class, the *Maryland* has shown a very perceptible advantage in coal economy. It is natural to suppose that there are reasons why this greater economy is present. The following is a recital and description of the various methods used in striving for this result. The methods are not new, but are in general a thoroughly practical application of matters that have been previously pointed out in both theory and in practice; but which, on account of not being thoroughly understood, are not carried out in practice by many practical marine engineers.

The first element to deal with in attaining economy is the boiler plant. Economy here depends upon (1) The design and arrangement of boilers. (2) The care exercised in keeping the boilers clean and in thorough repair. (3) Efficient firing.

BOILERS.

The boilers are of the latest Babcock and Wilcox type. They are accessible on all sides, and have roomy firerooms. These conditions make it possible for them to be well taken care of without any great amount of difficult labor. They are arranged so that they can be cleaned of soot while steaming, and in port they can be thoroughly cleaned with comparatively little trouble. In this particular this vessel has an advantage over some of her sister ships, whose boilers can not be as readily cleaned.

The sister ships in squadron are the *West Virginia* and *Maryland,* built by the Newport News Shipbuilding and Dry Dock Company, fitted with Babcock and Wilcox boilers; and the *Pennsylvania* and *Colorado,* built by William Cramp and Sons, fitted with Niclausse boilers.

The following rules are established on the *Maryland* for firing boilers, and for their routine care and management:

ORDER FOR THE OPERATION OF THE BOILERS.

The general routine for procedure in the boiler rooms is to be strictly followed while boilers are under steam. In addition, the following rules are to be adhered to:

FIRING.

Coal will be thoroughly broken up and lumps no larger than the fist will be put into the furnace. Furnace doors will be opened just as little as possible. Furnaces will be fired in regular rotation, and must not be choked near the furnace doors. No more than five shovels full of coal will be put into one fire at one time. The fires will be pushed well back from the furnace doors, and the dead plates will be kept absolutely clear of coal. Slicing will not be done until absolutely necessary to break up the clinkers.

Unless otherwise directed, tubes will be swept with steam by the watch that relieves the watch that has cleaned the fires. The chief water tender will give directions as to the time of cleaning fires, and will be responsible for their proper condition.

When burning about 20 pounds of coal per square foot of grate per hour, fires will be cleaned every 24 hours. Fires will not be carried over 7 inches thick, as per aluminum paint mark inside the furnace door. The fires will be carried level over the entire grate. Just before time for firing the furnace, the fire will be raked over with a small hoe, and at time of firing, the coal thrown evenly all over the fire.

Boilers will be blown with slight surface blow first, then a slight bottom blow every day at 7 p. m. The water tender on watch will be responsible for carrying out the order. One pound of soda or lime will be put into the feed tank at every morning watch for every boiler in use. Machinist on watch will see this done.

As soon as the fires are out, unless under special order to the contrary, on account of repairs, etc., boilers will be given first a surface and then a bottom blow, and afterwards pumped full of fresh water well up to the upper gage cock, to insure water level being well above the opening of the upper tubes. As soon as fires are allowed to die out, and the boiler is cool, the fire sides of boilers will be thoroughly cleaned of soot. The

grate surface will be overhauled, leaks repaired and the boiler in general put in shape for steaming when needed.

ORDERS FOR FIRING BOILERS.

Whenever in steaming watch, furnaces will be fired in regular order as numbered. Each fire will be leveled immediately after the furnace two numbers ahead is fired. Thus, when No. 2 is fired, No. 4 will be leveled, when No. 3 is fired, No. 5 will be leveled, when No. 4 is fired, No. 6 will be leveled, and so on. If more or less coal is to be burnt, the firing interval will be changed, firing oftener or less frequently, as required. With one inch air pressure, a furnace should be fired each minute; with natural draft, about each minute and a half.

Cleaning Fire Sides.—Special care is taken to thoroughly clean the fire sides whenever fires are allowed to die out. The usual method is to loosen up the soot with hand brushes through the cleaning doors, and to haul out the accumulation of soot from above the horizontal baffle. Then put on forced draft, about 2 or 2½ inches pressure on the boiler compartment, open ash pans and dampers and assist the loosening up of the soot by means of the steam lance through the dusting doors. In this way all the dirt is driven up the smoke stack, and the fireroom is not dirtied to any great extent. The fire sides of boilers are very thoroughly cleaned in this way.

Whenever boilers are used for any extended period underway, the tubes are swept with the steam lance through the dusting doors at regular intervals. Under forced draft and with proper light, smokeless fires practically no soot collects. Therefore we see here a most important reason for keeping fires from smoking. The keeping of fire sides of tubes thoroughly clean is a most important item for obtaining the economical performance of boilers.

Care and Cleaning Water Side.—The main points under this heading can be seen by noting the instructions. They are, namely, regular use of surface and bottom blow every day, a regular supply of soda, special care in keeping air out of boilers, and the maintenance of clean fresh feed water. The soda is added to keep the oil from depositing in the tubes, and the blowing to get rid of the oily scum at surface and the accumulation of dirt at bottom.

The regular use of cylinder oil is prohibited, and a grease extractor is fitted on dynamo air pump discharge and filter boxes on the feed tanks. But in spite of these precautions some oil finds its way to the boilers, and collects on surface of tubes. To remore this oil deposit the boilers are either boiled out or cleaned with turbine cleaner.

To boil out: the boiler is opened, about 20 gallons of kerosene and 30 pounds of caustic soda for every 100 square feet of grate surface are put into the boiler, which is closed and filled to lower part of drum with water. A small steam connection is made to the bottom of boiler, then steam is turned on, the water is caused to boil at about 50 pounds pressure for several days, the boiler being in the meanwhile given a surface and bottom blow periodically. When boiling is finished, boiler is given first a surface blow and then entirely emptied. This process of boiling removes the deposit, or causes it to become dry powder, which can be washed out.

Cleaning with turbine: the deposit of oil and dirt may become so thick that boiling will not remove it properly. Then recourse is had to the turbine cleaner, which instrument completely removes all deposit. This cleaner is operated by a hose led from one of the auxiliary pumps. The turbine is inserted in the tube and water pressure put on. The turbine revolves at high speed and the arms carrying the cutters press out against the sides of the tube and remove all deposit. The turbine is hauled back and forth through entire length of tube until clean. The water, on leaving the turbine, washes out the loosened sediment, and carries it out of the ends of the tubes.

Firing.—By the system of keeping light, regular, thin and smokeless fires as described in the instructions, and by avoiding slicing as much as possible, all the coal is actually burned. The avoidance of smoke is most important; first, by reason of smoke being a direct loss as unconsumed fuel; second, because smoke causes the collection of soot on the tubes, thus rendering their heating surface less efficient; third, because smoke is a cause of much dirtiness of decks, boats, guns, etc.; fourth, because much smoke is undesirable for military reasons. A smokeless fire means cleaner heating surface, and hence greater boiler economy. Continual and unnecessary slicing results in great waste of fuel, as particles of coal are continually dropping into the ash pans. In order to attain economy slicing must be avoided as much as possible.

HANDLING OF HEAT.

Having obtained steam at the boilers with the least expenditure of coal, the next problem for securing economy is to handle the heat units thus secured in the most efficient manner.

Jackets.—The first item is the use of steam jackets. Jackets are used constantly. The pressure in intermediate and low-pressure jackets is maintained at a pressure above that of the steam in those cylinders. That in the high-pressure jacket is kept at about 150 to 200 pounds. This lower pressure is used to avoid excessive heating of the walls of the high-pressure cylinder. Such heating would cause the steam to become very dry, and this would bring about difficulties in lubrication, excessive friction and cutting and scoring of cylinder and valves.

Adjustment of Links.—The next item to consider will be the adjustment of the links of the valve gear. To secure the greatest economy, the steam should be expanded as many times as possible. Hence the high-pressure cutoff, which regulates the rate of expansion is always made as early as possible, provided the desired number of revolutions can be made with the steam at working pressure of boilers. When more speed than this is required, the cutoff is run out just sufficient to obtain the necessary revolutions.

In this way the greatest range of expansion under any and all conditions is obtained, and hence the most economy, from the principle of expansion, is secured. This regulation of the links is of extreme importance in securing economy, and is a matter that is not, as a rule, properly understood; for this reason the position of cutoff is very often not looked at at all, or else the cutoffs are adjusted in a manner that will not secure the highest economy.

For example, let us suppose the vessel is running at low power, say one-third power, ratio of low-pressure to high-pressure piston is 7.5, and under condition *A*, the high-pressure cutoff is set at 0.6 stroke, steam at high-pressure chest 175 pounds. Under the other condition *B*, the cutoff is all the way in, at 0.45 stroke, steam pressure at high-pressure chest 240 pounds. The number of expansions for condition *A* is 12.5, for *B*, 16.6. The expected steam consumption for *A* is 15.4 pounds of water per horsepower per hour; for *B* it is 14.3 pounds of water per horsepower per hour. The above pressures for steam at high-pressure chest are the pressures necessary to secure the same revolutions under the two different positions of high-pressure cutoff.

The above figures for steam consumption are taken from tables of expected mean effective pressure, assuming 65 percent card effect; and the pressure at high-pressure chest and expansions as given above.

In the above case the changed conditions produced an increase in economy of 7 percent, and in actual practice a similar result is effected.

Vacuum.—The next point in the handling of the heat is in securing the highest possible vacuum. The air pump must be continually watched, and when less than 27 inches is shown, the reasons for this drop ascertained and remedied. The pump must be kept constantly in good condition, and the exhaust piping absolutely tight.

In the regulation of the circulation pump, a temperature of

discharge below 100 degrees Fahrenheit must be maintained, to secure a vacuum of 28 inches. With very hot circulating water, above 80 degrees, it may, however, be impossible to obtain a vacuum above 26 inches. The maintenance of high vacuum is most essential to secure economy. It is something very often overlooked or carelessly regarded, many engineers being satisfied with 24 inches of vacuum, when by more care and oversight 27 inches could be obtained.

Hot Feed Water.—We have now come to the most important item of all. By the use of what up to a few years ago was ordinarily waste heat in marine practice, such as trap drains, vapor from evaporators, and the heat of the auxiliary exhaust steam, a temperature of feed water reaching 200 degrees and above can be maintained.

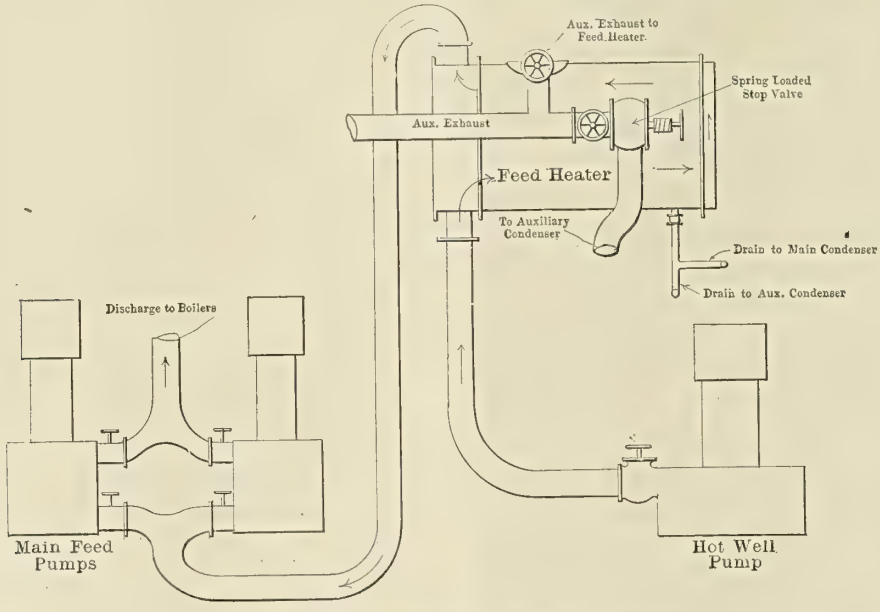
The evaporators are usually worked in double effect, and when so operated are arranged so that the drain from the low pressure evaporator coils, which is the steam made in the high-pressure shell, is led to the feed tank direct as make-up feed, instead of being led to the distillers. The heat contained in the drain water is thereby saved, instead of being lost in the distiller circulating water.

their actual consumption of steam but slightly. When the exhaust steam is used to heat up the feed water, instead of being led to the condenser, the latent as well as the sensible heat it contains is absorbed by the feed water, and is thus saved and retained in the system.

The saving by heating feed water to 200 degrees F. by auxiliary exhaust at two or three pounds pressure, over the practice of running auxiliaries on a vacuum with no feed heater, is fully 10 percent in actual practice. Aside from this, hot feed water is much easier on the boilers. It is not believed to be advisable to keep a greater pressure than 5 pounds on auxiliary exhaust, on account of the increased loss of water from leaks in the auxiliary exhaust system.

The system of feed water heating on the *Maryland* may be made plain by the description and accompanying sketch.

The auxiliary exhaust is led to a closed feed water heater. This heater consists of a shell and a nest of tubes, the feed water circulating through the tubes as indicated. The steam is on the outside of the tubes. The feed water is pumped through the heater by means of the hotwell pump, which draws from the feed tank, and the water discharges, after leaving the heater, to



LAYOUT OF FEED WATER HEATING PLANT ON MARYLAND.

The evaporators are also arranged so that the vapor can be led to the auxiliary exhaust line. When underway, and the exhaust steam from the auxiliaries in operation is not sufficient to maintain a temperature of 200 degrees with 2 or 3 pounds pressure in auxiliary exhaust, the vapor from the evaporators can be put into the auxiliary exhaust for make-up feed, and its heat will be utilized to raise the temperature of the feed water. By operating the evaporators in this way there is theoretically no loss of heat due to the make-up feed water. In actual practice there is however, a considerable loss of heat due to reducing pressure, leaks, radiation, etc. In order to guard against the danger of drawing over salt water with the vapor it is necessary to have a pressure of several pounds above the atmosphere in the exhaust line, and to throttle down the valves on the evaporator shell so as to wiredraw the vapor.

The chief source of heat for heating the feed water is the auxiliary exhaust steam. The auxiliaries that use an appreciable amount of steam are feed and bilge pumps, air pumps, ash hoists, blowers and ice machine; all simple engines; and the circulating pump engines, which are compound. The reciprocating pumps and the simple engines do not use the steam expansively, and hence a vacuum is not necessary or even important for their proper operation; therefore, raising the back pressure in the auxiliary exhaust line to two or three pounds pressure will affect

the suction of the main feed pumps. A pressure of 10 to 30 pounds is maintained. The main feed pump takes the hot feed water and pumps it to the boilers. The heater is drained by a small drain pipe, discharge from which may be turned into either the main or the auxiliary condenser. There are no traps in this drain line.

The admission of the exhaust steam into the heater is controlled by a stop valve and a spring loaded relief valve, which can be adjusted so that when a certain pressure in the exhaust line is exceeded the valve will lift, and allow a portion of the excess steam to pass into either the main or the auxiliary condenser. At sea, the auxiliary condenser can be shut down and the excess steam and drain led to main condenser.

By keeping 2 or 3 pounds pressure on the auxiliary exhaust, a temperature of 185 to 210 degrees F. is regularly maintained for the feed water. As the power is increased, necessitating more feed water, the steam used by the auxiliaries also increases, and an approximate balance is kept.

In port, the feed heater is used, the discharge from dynamo, air pump and the various drains being the only water discharged direct to the feed tank. The pressure in the exhaust line is, however, lowered, generally to between 0 and 5 inches vacuum. By keeping a slight pressure on the auxiliary exhaust line, air is kept out of the system, a result to be desired.

To maintain continually the high temperature of feed necessitates careful watching to see that heaters are properly drained, that pressure in auxiliary exhaust is kept at desired point, that the spring loaded valves are properly adjusted, and that they work.

REDUCTION OF AVOIDABLE LOSSES FROM LEAKS.

The principal losses are due to steam leaks of various kinds. Leaks in the steam piping are overcome only by exercising the greatest possible care to keep every joint constantly tight. This means constant care, oversight and labor, but the increased economy and efficiency more than repay the extra care and trouble.

A very perceptible loss may be the leakage past steam valves leading to and from steam traps and various drains. In this particular the advantage of having a thoroughly reliable steam trap is brought to light. The steam traps on the *Maryland* are of the Kielly and Mueller type. Usually, when traps do not work properly, their by-pass valves are opened; then, of course, the steam blows directly through to condenser or feed tank. This, of course, is a very considerable loss, especially on a large vessel, where traps and drains are very numerous. In order to have traps in proper working order they must be frequently overhauled.

REDUCTION IN STEAM CONSUMPTION OF AUXILIARIES.

Feed Pumps.—Economy is gained by running fewer pumps at nearly full capacity, rather than a greater number at low speed.

Circulating Pump.—This is one of the largest auxiliaries in use, and by paying proper attention to the necessities of its use a very perceptible gain may be made. It is a common practice, at low powers, to run the circulating pump very much faster than is necessary to supply the required circulating water. If a vacuum of 28 inches is aimed at, it is never necessary to have the discharge water below 95 degrees, and when the temperature of the discharge water is below this the circulating pump should be slowed.

The slowing of the pump in this case has the double effect of requiring less steam for its own operation, and also of causing the water in the feed tank to be warmer; at the same time the maximum vacuum is obtained in the main condenser.

Dynamos.—In a modern ship of war the dynamos use a large percentage of the steam used for auxiliaries. To reduce this consumption, all unnecessary lights and electric auxiliaries should be shut off whenever possible. The dynamo condenser should be run to secure the highest vacuum that can be maintained. The dynamo plant on the *Maryland,* in conformity with the latest practice on large vessels, has a condensing plant of its own. This consists of a Wheeler condenser, with combined air and circulating pumps located in the dynamo room.

SUMMARY.

The principal causes that have tended to produce economy on the *Maryland* are as follows:

1. Care in firing, keeping fires thin and avoiding smoke.
2. Care in keeping boilers thoroughly clean, both inside and out.
3. Use of steam jackets.
4. Using steam at as great a range of expansion as possible by keeping high-pressure cutoff run in as long as the required power can be developed.
5. Maintenance of good vacuum; 27 inches is usually maintained.
6. Maintenance of hot feed water, generally at or above 200 degrees Fahrenheit.
7. Exceedingly great care to avoid steam and water leaks of all descriptions; at stuffing boxes, joints, etc.
8. Operation of evaporators in double effect, and on auxiliary exhaust when under way.
9. Special care to reduce internal friction of all steam cylinders by frequent overhauling, wiping out cylinders and coating them with graphite or graphite grease.
10. Care in shutting down all unnecessary auxiliaries when they are not required.

In general, it may be said that by paying special attention to every little item of loss or possible gain, no matter how small and how indirect, a great saving is obtained. At the same time the conditions that tend to saving in coal produce increased working efficiency and freedom from repairs.

The consumption of coal on the *Maryland* has at sea, been 10 to 20 percent less than that of her sister ships. The saving in money thereby is very considerable, but the saving in general efficiency is much greater. The steaming radius is correspondingly increased, while the work of coaling ship and handling the coal in the bunkers and fire rooms is decreased.

SIDE LAUNCHING OF SMALL STEAMERS.

At the boat yard of Louis Henley, Phœnix, N. Y., some difficulty in launching is experienced, because of shallow water opposite the yard, and, as the boats have to be launched across a tow path, preventing the laying of permanent ground ways for end-launching, it has been found necessary to adopt side launching for the canal boats and steamboats built in the yard.

JUST BEFORE LAUNCHING, SHOWING HANGING WAYS.

These two classes of boats are launched in different ways, the first method being that for canal boats, which are entirely flat bottom. These boats are set up 16 or 18 feet from the edge of the tow path, and three beech ways, about 50 feet long, made each from a tree flattened on two opposite sides, are placed

THE VESSEL STRIKING THE WATER.

under the boat, after having been well tallowed. Shoes are made of beech plank laid across the ways beneath the boat, one being placed on each side of the bottom of the vessel. When constructing the boats, they are set up level, without any grade, and the ways are wedged up tight to the boat, hanging out from the center line over the water unsupported.

From the center line blocking to the edge of the bank under each way are placed blockings provided with such a grade as to give the necessary declivity for launching the boat. Under the center of the side of the hull next the water is set a stout shore, which is afterwards used as a trip, and is driven out by a ram when the boat is to be launched. When everything is ready for placing the boat in the water, the lower blockings are removed by placing the boat upon jack screws, thus leaving the weight of the ways hanging on the trip. When the latter is driven out, the ways tip the boat to the proper grade, and the launching becomes an accomplished fact. There is a perpendicular drop at the edge of the tow path, amounting to from 3 to 6 feet, depending upon the stage of the water in the river, but no difficulty has been experienced on this score.

THE RIGHTMYER AFLOAT AFTER SIDE LAUNCHING.

The other method is used for steamboats, and consists in laying three ways to the proper grade while leaving the boat level. A long shoe, with guides, is bolted on at the upper end to the center way, and the space between the boat and the shoe is blocked up solid. At the time of the launching all blocks are removed, leaving the boat resting upon the shoes, but held from starting by the bolts through the center shoe. When this plank is sawed off below the bolts, the boat is started upon the ways.

Our illustrations show the launching of the canal freight packet *Rightmyer,* which measures 96 feet by 17 feet.

The World's Shipping.

Editor International Marine Engineering:

In taking up the tables of the shipping of the world presented in Lloyd's Register for 1906, the writer noticed with considerable surprise that with the single exception of Japan, the shipping of the United States had made a greater progress in *percentage* during the year than had that of any other nation listed. The figures for percentage are based upon those given in the accompanying table under the heading of "Equivalent Steam," an explanation of which term is in order.

It has been generally considered that the mercantile or commercial value of a sailing vessel of a given tonnage is considerably less than that of a steamer of equivalent tonnage. Various authorities have given different figures for the ratio, but one which is quite commonly adopted is 1 to 4. On this basis the equivalent steam tonnage given in the table is formed by adding to the steam tonnage of each nation one-fourth of the sail tonnage. Of course, the result is considerably less than the total tonnage of the nation in question, but it is a somewhat more reliable index to the total commercial value of the mercantile marine.

It will be noted that the entire tonnage of the world has increased 5.48 percent. British tonnage has not kept up with the average, while American, German, Russian, Swedish, Danish and Japanese are considerably above the average in percentage of increase. The French is almost stationary, showing a very slight decrease, while the Spanish decreased 1.27 percent. The other nations all show increases not far different from the average for the entire world. It will be noted that the tonnage of the United States, above-mentioned, does not include the Great Lakes, but that it is very largely made up of coastwise tonnage.

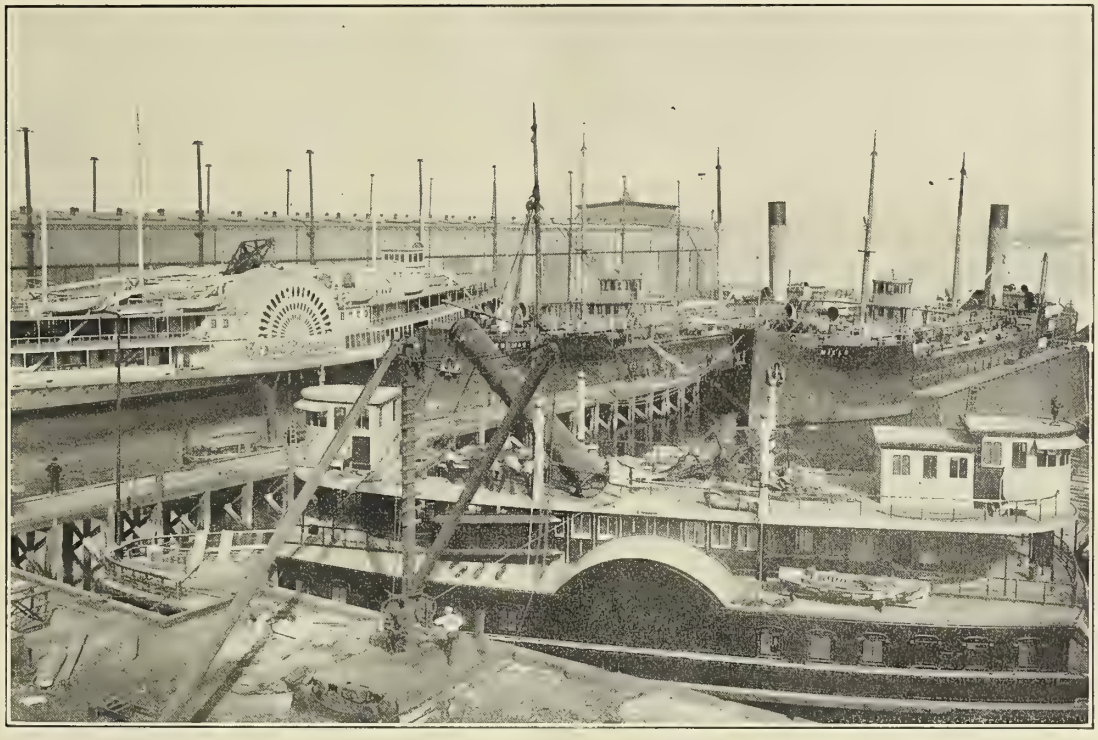
While it is utterly out of the question to suppose for a moment that the percentages of increase from 1905 to 1906 can be expected to be maintained for any considerable period of time, yet it is interesting to know that if these percentages *were* continued, the American merchant marine would pass in tonnage that of Germany in the year 1925, each nation at that time having,

1905				Nation	1906				Increase percent
Steam	Sail	Total	Equivalent Steam		Steam	Sail	Total	Equivalent Steam	
15,409,538	1,600,182	17,009,720	15,809,584	Great Britain	16,166,748	1,444,348	17,611,096	16,527,835	4.54
3,093,702	471,096	3,564,798	3,211,476	Germany	3,375,743	434,610	3,810,353	3,484,396	8.5
2,558,694	1,437,785	3,996,479	2,918,140	United States	2,827,756	1,413,833	4,241,589	3,181,214	9.03
1,260,973	467,065	1,728,038	1,377,739	France	1,253,737	487,458	1,741,195	1,375,602	— 0.15
1,081,335	694,883	1,776,218	1,255,056	Norway	1,145,545	692,334	1,837,879	1,318,629	5.06
870,839	2,713	873,552	871,517	Japan	996,553	3,540	1,000,093	997,438	14.45
741,110	447,956	1,189,066	853,099	Italy	775,069	429,359	1,204,428	882,409	3.44
639,062	223,847	862,909	695,024	Russia	694,063	219,070	913,133	748,831	7.75
592,695	211,651	804,346	645,608	Sweden	650,768	205,930	856,698	702,251	8.78
693,265	38,316	731,581	702,844	Spain	684,339	38,173	722,512	693,882	— 1.27
659,409	42,345	701,754	669,995	Holland	683,180	36,115	719,295	692,209	3.32
604,669	13,525	618,194	608,050	Austria	618,031	12,446	630,477	621,143	2.15
537,242	89,270	626,512	559,560	Denmark	579,464	80,837	660,301	599,673	7.17
1,220,859	296,867	1,517,726	1,295,076	All Others	1,293,908	311,060	1,604,968	1,371,670	5.91
29,963,392	6,037,501	36,000,893	31,472,768	Total	31,744,904	5,809,113	37,554,017	33,197,182	5.48

according to this calculation, a tonnage about equivalent to that now possessed by Great Britain and her colonies. At that time the British tonnage would be considerably more than double what it now is, while the Japanese, with the large percentage of increase shown during the last year, would not be very far behind the German and American. Such computations are, of course, mere idle speculation, and really involve nothing more than a calculation based upon compound interest.

It will be noted that there are no less than thirteen nations, each of which has a tonnage of more than five hundred thousand, but that only five of these nations have as much as one million tons, the remaining eight being pretty closely grouped, and exhibiting from year to year fluctuations in relative position in the column. Thus it will be noted that during the year, both Russia and Sweden have passed Spain, and Sweden has also passed Holland. Another feature of the table which may cause a little surprise is that Spain, in spite of a decrease during the year, still has a larger tonnage than has Holland. Another surprise is in the very creditable growth in Russian tonnage.

The total steam and sail tonnage included is 37,554,017, as against 36,000,893 in 1905, and 34,789,189 in 1904. It will be noted that the steam tonnage has increased during the year from 29,963,392 to 31,744,904, or 6 percent. During the same period, sail tonnage has decreased from 6,037,501 to 5,809,113, or 3.79 percent. At the present rate of change, it will not be long before the sail tonnage will have become almost insignificant in comparison with that propelled by steam. It is only within a year or two, however, that the *number* of steam vessels included in the tables has reached and passed the figure represented by the number of sailing vessels so included. N. S. Yendis.



THE JERSEY CITY REPAIR YARD OF THE JAMES REILLY COMPANY.

A New York Harbor Repair Yard.

The James Reilly Repair & Supply Company has recently been making some extensive improvements, both at its manufacturing and repair plant in Jersey City, and in its supply department at 229-230 West street, New York.

The Jersey City plant has been entirely rebuilt, and equipped with all modern tools and appliances for marine work, as well as for manufacturing engineering specialties. The company has built in front of its works a mooring pier six hundred feet long, where vessels can have a comfortable berth while undergoing repairs. The location of this plant is one of the most convenient in the harbor of New York, being immediately next to the Pennsylvania Railroad ferries, running to Twenty-third street, Desbrosses street, Cortlandt street, and the Brooklyn annex. There are two P. R. R. switches in the place, one at Grand street and one at Sussex street, making it convenient to load and unload machinery and supplies. A small industrial track runs all around the building, to facilitate the handling of heavy material. Duplicate air compressors are installed, and air and water pipes conducted down to the end of the mooring pier. Since the remodeling of this plant the shops have been very busy.

The new supply building on West street is one of the most modern structures of the kind in the city of New York. It has been especially built and equipped for the purpose of conducting a ship chandlery, hardware, and contractors' supply business. The building is six story, 50 by 110 feet inside, has two electric elevators, and contains, besides the supply department, the general offices of the company.

In 1892 the company was incorporated, and took over the operation of the repair shops formerly conducted by the International Navigation Company (American and Red Star Lines) at Jersey City.

The business has steadily grown from a very small beginning to one of great proportions, and is peculiar in itself, inasmuch as it embraces everything required for a ship. It might truly be called a marine department store, where the ship owner can have his vessel dry docked, repaired, and completely stored with everything required for a long voyage.

MOTOR BOATS.

PART XVI.

BY DR. WILLIAM F. DURAND.

TROUBLES, AND HOW TO LOOK FOR THEM.

The number of ways in which a gasoline engine may fail to operate properly, and the number of causes which may contribute to trouble, are legion, and within present limitations only some general principles can be given as an aid in locating trouble when it arises. The location of trouble in the operation of a gasoline engine is exactly a process of diagnosis, and this again is a process of analysis and isolation. The operation, as a whole, must be resolved into its various parts or functions, and one item after another of the mechanism and equipment must be examined, in order to gradually isolate, and thus by a process of exhaustion ultimately locate, the seat of the trouble.

The operation of a gasoline engine, aside from the mechanism itself, demands the simultaneous realization of two chief functions or conditions:

(1) An electric spark of sufficient intensity to ignite a proper mixture of gasoline vapor and air compressed to a point suitable for such ignition, and occurring at or near the end of the compression stroke.

(2) The provision of a charge of gasoline vapor mixed with a suitable proportion of air and compressed at the end of the stroke to a pressure suitable for ignition.

These two main conditions, one referring to the electrical spark and the other to the charge of gasoline, are, of course,

quite independent, and may be taken up each in turn, and in either order, until the trouble is located.

In the absence of specific indications, as referred to later, the point of most direct attack is usually the existence or non-existence of a spark. This can generally be ascertained by such observations as will readily present themselves to mind. If a full and adequate spark is formed, then attention must next be given to the question as to whether it is formed at the right point in the stroke. It is perfectly possible for a commutator to become disturbed in adjustment, or for other derangement to displace the instant of forming the spark relative to the piston position, to such an extent as to render it of no avail for the ignition of the charge. In short, here, as at all other points, care must be taken to insure the complete fulfilment of all items of the electrical condition—not alone the existence of a vigorous spark, but one so located as to come at or near the end of the compression stroke, and thus available for the ignition of the charge. If no spark whatever is formed, or if it is feeble or uncertain, then there is trouble somewhere on the electrical side, and the problem becomes one of further localisation.

We must remember that electrical energy operates in closed circuits, and that a break or disturbance at any point in such a circuit may prevent its performing its proper function. In the wipe contact system of ignition there is one such circuit, in the jump spark, two. In a search of this character we may either start from the batteries as the fountain head, and follow down to the ignition plug or wiper terminals, or we may proceed in the inverse direction. Usually the former is the more satisfactory and definite in results. Thus, place a voltmeter or ammeter across the terminals of the battery, or in the absence of such instruments, watch for a spark when shortcircuited and broken by a bit of wire, or better still by a small magnet coil. The spark, or its absence, will show whether the battery is in good condition. If not, a broken or poor contact may be found at some of the terminals or connections between the cells. It may even be necessary to test out each cell separately, thus giving definite assurance in the end that the battery is or is not at fault.

If the battery is all right, and the wipe spark is used, then the instrument or short circuiting coil applied along at one or two intermediate points will serve to bring the problem down to the engine, and if the search has been properly carried out, the trouble will surely be found by the time we reach the wiper terminals in the cylinder. In general, electrical trouble must be looked for at junctions and connections, and at the terminals in the cylinder. The conditions for good electrical conductivity are simple—continuous connection and good firm contact between bright metallic surfaces; and search should be especially directed to see if these conditions are fulfilled.

If the jump spark system is used, the same principles apply, but we may find troubles differing in detail Thus, the vibrator or make and break of the primary circuit may be out of order, and thus fail to operate with its accustomed buzz. If the primary current itself is all right, then trouble at the vibrator is of a mechanical nature, and is usually a matter of adjustment of the armature and controlling springs. Cases have been known where, with a relatively weak spring, the rate of vibration of the armature was too slow for the higher speeds of the engine, while quite sufficient for low speeds. In consequence, the engine would operate quite satisfactorily at low speeds, but would begin to miss fire and operate irregularly at the higher speeds. A stiffer spring with proper adjustment and suitable battery power is the remedy indicated.

Again, within the cylinder, the sparking points may become separated too far, or incrusted with non-conducting substance to such degree as to impede or interrupt the passage of the secondary spark. In any and all cases the same general principles apply. It is simply a matter of careful search at one point after another, conducted in an orderly manner, and in such routine as to gradually eliminate one possibility after another, until finally, by a process of exclusion, the difficulty must be located.

If the first direct test at the terminals of the electrical circuit indicates no trouble of an electrical character, then the location of the trouble must be sought in the other general condition, that relating to the explosive charge. Here the general conditions to be fulfilled may be classified under perhaps four headings, as follows:

(1) The supply of gasoline must be ample, but not in excess.

(2) It must be vaporized, and mixed with a proper proportion of air.

(3) It must be compressed to a pressure suitable for ignition.

(4) Waste gases or foreign substances, such as cylinder oil, carbon deposit, etc., must not be present, beyond a safe small amount.

In the search for trouble, all of these conditions must be borne in mind, and by the same general policy of exclusion the trouble must ultimately be located. Trouble with the supply of gasoline may arise in a variety of ways. The supply in the tank may be exhausted; the air relief valve or opening may be closed; some valve or turn or pipe may be clogged with sediment or foreign matter; some connection or pipe may be broken, and the supply thus interrupted by leakage; the carbureter may be out of order by clogging or by lack of adjustment; the opening of the gasoline throttle may be too great or too little, either flooding the cylinder with an excess or furnishing an inadequate supply.

Again, trouble in vaporization or with the proportion of air may be due to faulty construction of the carbureter or to faulty adjustment, especially with reference to the air supply.

Failure to secure proper compression may be due to a leaky piston, or, in the case of a four-cycle engine, to leaky valves, either supply or exhaust, allowing the compressed vapor to escape instead of retaining it in the cylinder to the proper point of compression.

The quality of the charge may be injuriously affected by the presence of waste gases in too great proportion, or by cylinder oil or carbon in undue amount. The presence of these latter may be prejudicial, not primarily because of their effect on the explosive character of the charge itself, but rather, as previously noted, because they are liable to clog the sparking points, and require an electrical pressure greater than the battery can afford in order to make an effective spark.

Troubles of a mechanical character may also arise in great number, but to these we shall give no present attention beyond the general caution that all bearings, pin joints and connections must be carefully watched for wear, proper lubrication must be insured, and in particular the condition of the piston and inner surfaces of the cylinder must be safeguarded by sufficient but not by an excess of cylinder oil, and by an adequate and continuous supply of cooling water.

SYMPTOMS OF TROUBLE.

As with diseases in the human body, the same symptom may often be due to widely different causes. Still, an intelligent and critical examination of the symptoms will often give valuable indications regarding the cause of the trouble, and in any event, before any general hunt for the location of trouble, a careful study of the symptoms should be made. Some of the more common symptoms are noted below, with the possible indications to which they may refer.

(1) *The explosions cease suddenly* and without warning, bringing the engine from full power to a sudden stop. The trouble here is probably electrical, and the symptoms imply a sudden break in the electrical circuit or derangement in the electrical apparatus, cutting off the spark suddenly and completely

(2) *The explosions miss occasionally* and with varying frequency. This condition may be due to a variety of causes. The

battery may be losing its strength, or there may be a vibrating contact. By the latter is meant a point where the copper of a wire is broken, but the ends are so held by the insulation, or otherwise, as to remain nearly in contact, and by the vibration due to running they may be occasionally brought into contact and thus allow the spark to form; or if normally in contact the vibration may occasionally separate the ends, in either case producing an irregular operation in accordance with the formation of the spark.

The same symptoms may also be due to fouling of the spark points, to fouling of the commutator with oil or foreign matter, to trouble with the vibrator, to improper quality of the explosive charge, to insufficient compression, or, in fact, to a derangement in almost any one of the many conditions which must be simultaneously fulfilled, and in such manner as to permit an uninterrupted fulfilment of such conditions.

(3) *Weak explosions.*—This symptom may be due to improper quality of the explosive charge due to derangement of the carbureter, or to any other derangement which may interfere with the quality of the charge; also to insufficient compression, and consequently incomplete or retarded combustion; also to the formation of the spark at the wrong point in the piston stroke. The size and character of the spark have also some influence on the strength of the explosion. This, as well as the preceding symptom, may thus be due to a wide range of causes.

(4) *The engine slows down or stops,* and examination shows that the cylinder is excessively hot, and that the piston moves very stiffly in the cylinder. These general symptoms indicate insufficient lubrication or cooling or both, and the sticking of the piston within the cylinder.

(5) *The explosions gradually become weaker* and the engine finally comes to rest. This result may be due to any continuous and perhaps rapid development of conditions which may serve to disturb the operation of the machine, and perhaps bring it to a standstill. The supply of gasoline may first be examined, and if adequate the most probable location of the trouble will be in the electrical circuit somewhere, and presumably in the batteries.

(6) *Muffler Explosions.*—An explosion in the muffler is due to the passage of unburned gas from the cylinder through the exhaust into the muffler. This usually implies faulty ignition, in which case an entire charge may pass into the muffler and become ignited by the hot gases from the following exhaust stroke, or by a bit of glowing carbon or otherwise. The cause of the faulty ignition may, of course, be traceable either to the quality of the charge or to the spark, or both, and the search for final causes must be sufficiently comprehensive to cover all possibilities bearing on these conditions.

(7) *Crank Case Explosions.*—These occur only in a two-cycle engine, and are due either to delayed ignition, or to a weak and slow burning mixture. In such case there is a possibility of the passage of flame from the cylinder into the crank case along the line of the entering fresh charge. The obvious remedy is to advance the spark, or to attend to the quality of the mixture.

The more common derangements may also be mentioned, together with a statement of the usual immediate consequences.

(1) *Ignition very late.*—Difficulty in getting explosions, and if obtained, the power developed is small and operation irregular. Liability to crank case explosions with two-cycle engines. The condition may also contribute to cause muffler explosions.

(2) *Ignition very early.*—Difficulty in getting explosions, or if obtained, the piston is momentarily retarded, excessive stresses are thrown on the working parts, and the operation of the engine is irregular and jerky.

(3) *Vibrator spring too weak.*—Engine will operate properly at moderate speeds, but ignition will become irregular as the speed is increased.

(4) *Poor electrical contact or break at any point in circuit.*—Uncertain spark or no spark and corresponding explosions.

(5) *Stoppage in gasoline pipe or connections.*—Engine slows down and stops.

(6) *Carbureter improperly adjusted.*—Quality of mixture bad, and engine will operate irregularly or not at all, or well at some speeds and poorly at others.

(7) *Exhaust valve not tight or spring too weak.*—Inflow of air with explosive charge, and disturbance in quality of mixture. Likewise, escape of mixture under compression and difficulty in obtaining proper pressure for ignition.

(8) *Inlet valve not tight.*—Escape of mixture under compression, and difficulty in obtaining proper pressure for ignition.

(9) *Piston leaky.*—Same general result as for leaky valves.

(10) *Excess of gasoline.*—Quality of mixture too rich. Difficulty in ignition or in starting engine. Smoke may show in exhaust—usually black in color.

(11) *Excess of lubricating oil.*—Spark points become fouled by solid carbon or viscid mixture, with uncertain or difficult ignition. Smoke shows in exhaust—usually light gray in color. Presence of carbon may cause preignition, kicking, or back firing into crank case or carbureter.

With reference to the entire problem of trouble hunting, it should be understood that the ability to quickly locate and to properly treat such troubles as are liable to arise in the operation of a gasoline engine cannot be acquired by any mere study of symptoms and causes or derangements and results. The study must be fundamental rather than symptomatic, and must have for its purpose the thorough understanding of the conditions of operation of a gasoline engine, and the development of an analytical habit of mind with reference to the logical connection between such symptoms as may appear, and the conditions of operation. With such habit of mind and a careful examination by the method of exclusion, the trouble may be surely and definitely located, and the remedy applied.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports under date of August 11, 1906, the following percentage of completion of vessels building for the United States Navy:

			July 1	Aug. 1
BATTLESHIPS.				
Nebraska	19 knots.	Moran Brothers Co.	95.16	96.
Georgia	19 "	Bath Iron Works	97.47	98.43
Connecticut	18 "	Navy Yard, New York, N. Y.	97.41	97.6
Vermont	18 "	Fore River Shipbuilding Co.	88.5	90.5
Kansas	18 "	New York Shipbuilding Co.	85.2	85.8
Minnesota	18 "	Newport News Co.	91.44	93.68
Mississippi	17 "	Wm. Cramp & Sons	59.86	60.83
Idaho	17 "	Wm. Cramp & Sons	58.07	59.
New Hampshire	18 "	New York Shipbuilding Co.	48.	50.3
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works	94.	94.6
South Dakota	22 "	Union Iron Works	91.8	92.4
North Carolina	22 "	Newport News Co.	50.5	53.87
Montana	22 "	Newport News Co.	44.72	47.66
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie & Levy Co.	98.77	99.22
Milwaukee	22 "	Union Iron Works	96.1	97.9
SCOUT CRUISERS.				
Chester	24 knots.	Bath Iron Works	36.88	40.8
Birmingham	24 "	Fore River Shipbuilding Co.	38.4	41.8
Salem	24 "	Fore River Shipbuilding Co.	39 3	42.6
SUBMARINE TORPEDO BOATS.				
Cuttlefish	.....	Fore River Shipbuilding Co.	75 9	81.7
Viper	.....	Fore River Shipbuilding Co.	62.	69.3
Tarantula	.....	Fore River Shipbuilding Co.	72.3	81.3
Octopus	.....	Fore River Shipbuilding Co.	59.	65.1

OBITUARY.

James Dredge, managing editor of *Engineering* (London), died August 16. Mr. Dredge was born in Bath, England, in 1840, and long occupied a position of great prominence in the engineering field, and particularly along the line of technical journalism. He was author of a number of books, and was repeatedly honored by royal commissions and decorations of various sorts.

THE NEW FLOATING COAL DEPOT IN PORTSMOUTH HARBOR.

BY FRANK C. PERKINS.

A most interesting floating coal depot has recently been designed and constructed for the British Admiralty, for storing great quantities of coal afloat under the most favorable conditions, placing the same in bags very rapidly by means of the latest labor saving devices, and without hand shoveling, to be discharged later to war vessels by modern transporting devices. The photograph shows the floating depot at her moorings in Portsmouth harbor, taking in coal from a 6,000-ton collier. The drawings show the method of working the Temperly transporters employed in the work of transferring the coal to and from the depot.

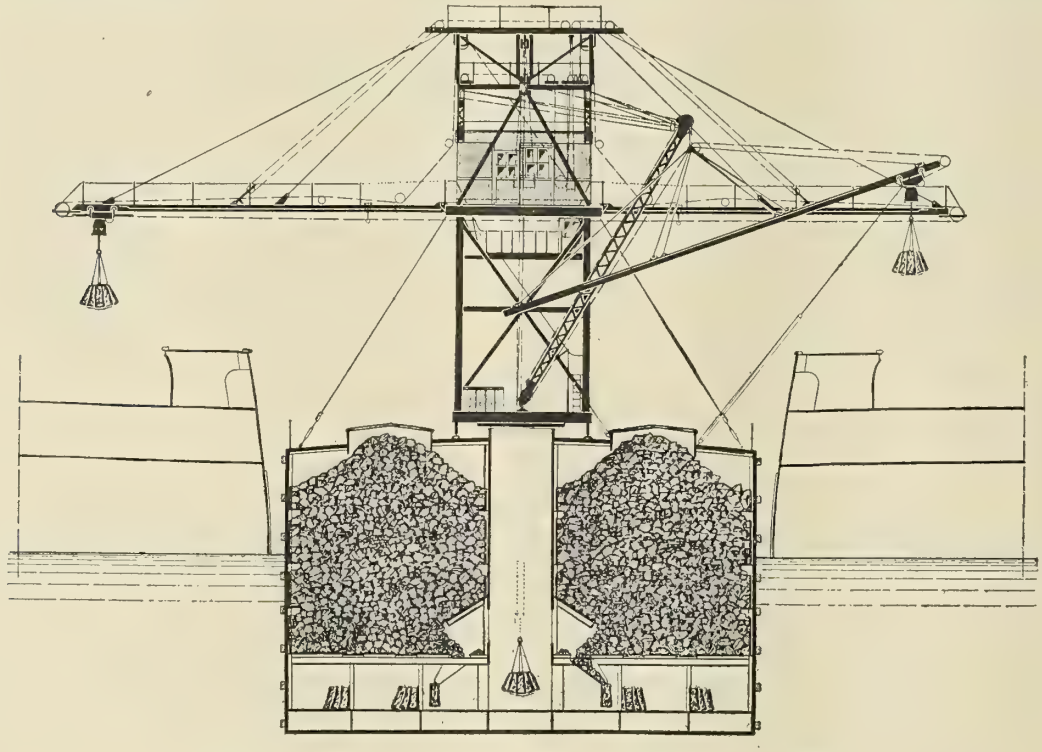
It is maintained that the advantages secured by the use of the floating depot are many, no valuable dock space being occupied, there being great storage capacity, and no breakage of coal in unloading, while the fuel is stored under cover. The mobility of the depot is also considered of great importance. The bags or skips are filled and assembled on smooth floors, while 10,000 bags may be kept filled below the hoppers, ready for immediate delivery at the exceptionally high rate of 700 tons per hour. There is also the advantage that two or more vessels can coal at once, and the fuel may be transported direct from the collier to the war vessel, while the men at work are sheltered from the weather, with perfect ventilation and freedom from danger.

It is claimed that the apparently insuperable difficulty hitherto experienced of getting Welsh steam coal to run or flow through openings in the bottom or sides of hoppers, owing to the large lumps of coal bridging over and blocking the opening when under pressure, is entirely and satisfactorily solved by this system. The result is obtained by the provision of suitable baffles so arranged in the coal spaces as to relieve the pressure from one row or several rows of openings, and at the same time afford safe shelter for a man to approach the openings and help the flow when any unusually large pieces get in the way.

As will be noted by the illustration and drawings, the hull of the depot is in the form of a large flat-bottomed, straight-sided vessel with bluff ends, and is of strong and simple construction throughout. It is subdivided by six transverse watertight bulkheads into seven compartments. There are five middle compartments which contain the ten coal hoppers, the after-end compartment containing the electric generating machinery, and the forward-end compartment being appropriated for crew accommodation and stores.

There are two longitudinal bulkheads in the middle of the vessel, which divide the five holds into ten hoppers, and afford a clear passageway between them, giving access through numerous openings to the spaces under the hoppers, and providing a clear exit up through which the bags of coal are hoisted by the transporters at any point in the length of the depot.

It will be noted that the bottom of the coal hoppers is raised above the floors of the vessel, and provided with trap-doors and movable chutes of special design for tapping the coal from below and regulating its flow into bags without shoveling. The chutes being entirely underneath the hoppers, the men operating them are safely protected from any coal dropping from the load.



SECTION OF FLOATING COAL DEPOT, SHOWING METHOD OF OPERATION.

Inside the hoppers, and next the longitudinal bulkheads, a sloping baffle deck projects over the nearest row of trap-doors, relieving these trap-doors from the pressure of the superincumbent coal, and allowing men to safely enter the hoppers through openings in the longitudinal bulkhead for the purpose of breaking up such lumps of coal as are too large to go into the bags.

A complete system of exhaust-air tubes is provided, and the coal dust arising at the chutes is drawn off by means of electric fans and delivered back into the receivers in the hoppers, where it may be subsequently bagged or otherwise dealt with. The suction of these exhaust tubes necessarily induces a downward current of fresh air, and so supplies the required ventilation.

There are three rows of very long hatchways provided throughout the length of the holds, the central row being over the central passage, for the discharge of the coal in bags, and the side rows over the hoppers for loading coal into the depot.

As seen in the views, the vessel is loaded and discharged by means of twelve transporters worked by electricity. The transporters are carried on four traveling towers, which run on a railway laid on the deck of the depot throughout its length. Three transporters are carried by each tower. Two of these

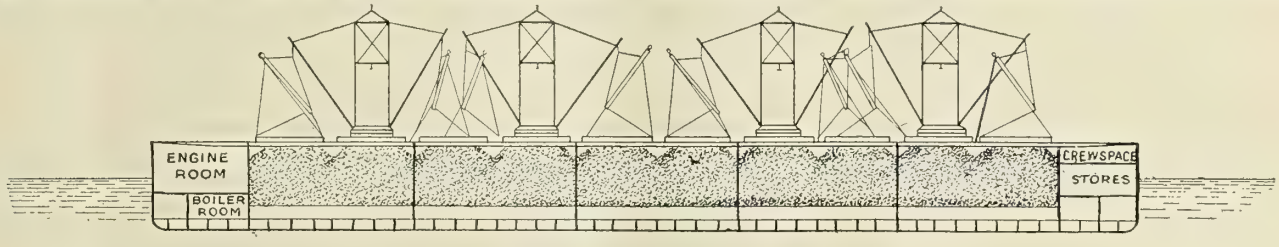
are inclined portable transporters of the latest standard pattern, and may be used for loading the depot from a collier, or for coaling a war vessel from the depot; the other transporter is horizontal, and long enough to reach from the hatchway of a collier on one side of the depot to the deck of a war vessel on the other. It may, therefore, be used not only in the same way as the other two, but also for transferring coal from a collier direct to the war vessel.

All the operations of traveling the towers along the railway on deck, raising and lowering the overhanging arms of the beams, raising and lowering the derricks with their portable transporters, hoisting and transporting the coal, etc., are performed by electric winches which are on raised platforms, from which the operators have a commanding view of the operations. Furthermore the four towers can be quickly moved by electric power to any required positions on the deck of the depot, and the twelve transporters can be easily trained either all over one side of the depot, or divided in any proportion and in any order between the two sides. The portable transporters being capable of being slewed through a considerable distance relatively to the towers it is practicable to so arrange all the transporters as to command every point along the deck of the vessel or vessels being coaled. This arrangement of the transporters gives the greatest possible range of action.

Automatic dumping skips are employed for loading the depot. These are lowered full of coal to within a foot or two of the coal already in the hold, but without resting on it, and are there automatically upset, so as to gently empty the coal on to the heap. When not in use the overhanging arms of the horizontal transporters are hinged up out of the way, the lifting and lowering being rapidly effected by electric gear. The portable transporters when not in use are slewed inboard. Under the hoppers the space is used for storing coal in bags, of which about 1,000 tons can be accommodated, thus providing a good supply for immediate and rapid transshipment. This storage space is utilized for filling bags in advance of requirements.

All of the electric power for working the twelve transporters, ten exhaust fans, and two electric windlasses, and for lighting the depot, is derived from three generators, having an aggregate output of about 600 horsepower, driven by steam, and placed in the after compartment of the vessel. Steam is supplied to the engines by two cylindrical return tube boilers.

THE COAL DEPOT LOADING COAL FROM A COLLIER ALONGSIDE.



LONGITUDINAL SECTION OF THE FLOATING COAL DEPOT.

Merchant Marine League Prizes.

The upbuilding of the shipping of the United States in the foreign trade is a subject which forms the *raison d'etre* of the Merchant Marine League of the United States, the headquarters of which are in Cleveland, Ohio. The fact that our shipping in foreign trade is less to-day in tonnage than it was in 1810, in spite of the stupendous increase in the aggregate amount of that trade, and the fact that it is only about one-third as great as it was at the outbreak of the civil war in 1861, have accounted for the organization of the League; and a campaign is being carried on looking to the institution of such measures as will result in placing this particular phase of our national life upon a basis commensurate with its importance.

Prizes aggregating $1,000 are offered by the League for the four best essays on "How to Build Up Our Shipping in the Foreign Trade," only students in high schools, technological schools, colleges, and universities in the United States being eligible to compete. There will be four prizes, viz: one of $400, one of $300, one of $200, and one of $100. Students desiring to compete for these prizes must register their names, and the institutions of learning which they are attending, with the League, in order to have their essays considered. Essays must not exceed 2,500 words; they must be typewritten, on one side of the paper only. The author's name must not be signed to his essay—only his nom de plume—which latter, with his full name and address, must accompany the essay in a separate sealed envelope. No limitation is set upon the method or plan that may be advocated; it may be along the line of protection or free trade. The contests will close about November 15, and the prizes will be awarded about December 15, 1906.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at
17 Battery Place - - NEW YORK
By MARINE ENGINEERING, INCORPORATED
Christopher St., Finsbury Square, London, E. C.

TERMS OF SUBSCRIPTION

	Per Year	Per Copy
United States, Canada and Mexico	$2.00	20 cents
Great Britain and Ireland	10/6	1/
Other countries in the Postal Union	10/6	1/

Entered at New York Post Office as second-class matter.
Copyright, 1906, by Marine Engineering, Inc., New York.
INTERNATIONAL MARINE ENGINEERING is registered in the United States Patent Office.
Copyright in Great Britain: entered at Stationers' Hall, London.

Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 5th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 1st of the month.

The edition of this issue comprises 6,000 copies. We have no free list, accept no return copies and issue only enough to supply the regular demand.

The New London Address.

Our London office has just been moved into much more spacious and commodious quarters in a new building on Christopher street, Finsbury Square, London, E. C. It is hoped that the new quarters will prove ample for our use for some time to come.

Engine Design.

It frequently happens in marine engineering work that a design is required of an engine to fulfil certain specific conditions, and under circumstances when time does not permit the development of a design from its inception, and the making of the necessary drawings. An engine of general utility, and of about 100 horsepower, thoroughly fitted for use in small boats using screw propellers, is presented this month with very considerable detail in the way of drawings. This engine has been thoroughly tested in practical work, as is evidenced by the report of the test, incorporated in the article, and has shown itself thoroughly well capable of performing the duty for which it was intended. While of course this particular design covers simply a single size and power, yet it is of sufficiently standardized character to be readily transformable into an engine of considerably greater or smaller size by relatively simple alteration of dimensions. The engine was designed for steady and somewhat heavy work in connection with boats in New York harbor, and would seem to amply fulfil all requirements in this respect.

This subject of standardization of engine details is one which has received considerable attention of late at the hands of the British Admiralty, and also among the merchant ship and engine builders of Great Britain. It is a matter of extreme importance, partly on the score of ready repairs and interchangeability of parts, and partly (on the manufacturing side) on the score of low expense for patterns and drawings, these covering often a considerable number of engines of the same power. Of course, as designs progress, alterations and changes are frequently made which improve the operation of each engine over that of those preceding, but in general the improvement is relatively slight in extent, and it is frequently doubtful if it is nearly as important as the matter of interchangeability of parts as between engines, and the possibility of making rapid repairs in case such should prove necessary.

An Epidemic of Shipwrecks.

There has been forcibly brought to our attention during the past few weeks the great liability of modern ships, however well built and operated, to disaster at sea, or, more particularly, in the neighborhood of the coast line; and in many cases to complete loss, in spite of all that could be done in the way of prevention, and of salvage operations after prevention became an impossibility.

The British battleship *Montagu* was lost early in the summer through running hard aground on Lundy Island in a fog, and being placed in such a position that in spite of the utmost endeavors nothing could be done to save the vessel, and but little in the way of saving her armament and equipment. Shortly after this, the American battleship *Alabama* went aground in Newport harbor, and the *Rhode Island* in Chesapeake Bay, but both were fortunately hauled off with little damage. A little later the American cruiser *Boston* went ashore near the entrance of Puget Sound, and was for a time supposed to be irrecoverable. The efforts put forward, however, were successful, and, although the ship had a bad leak, she was successfully removed from her position and taken to dry dock.

In the merchant marine, the Pacific Mail steamer *Manchuria* was run aground on one of the Hawaiian Islands and the *Mongolia* on Midway Island. A few days later the United States transport *Sheridan* ran ashore not far from the place where the *Manchuria* met her fate, and became a total loss.

In some of these cases investigations into the accidents have been made, and certain officers reprimanded for not taking the very best of care of their commands. As a general proposition, however, the mishaps to these various ships have come, not so much through negligence as through the operation of

fogs, or other natural phenomena which are extremely common at sea, and which cannot be prevented by any means at present open to mankind. It goes without saying that under such circumstances vigilance on ships at sea is redoubled, and when an accident occurs in spite of this increased vigilance, it simply serves to emphasize the utter dependence of sea-faring men on maintenance of such conditions of weather as will permit them to obtain frequent and accurate information as to their exact location upon the expanse of the ocean.

In the cases where these vessels were totally lost no reasonable provision in the way of extra strengthening of the bottoms would have prevented this loss, because of the fact that without introducing absolutely prohibitive weights the bottoms of ships cannot be made sufficiently strong to successfully sustain contact with hard rock formations. The intimate subdivisions of the double bottoms prevented in each case any sudden sinking of the ship after striking the obstacle, and fortunately no loss of life was reported. The number of accidents, however, coming so close together, serves to emphasize the extreme importance of extraordinary precautions under circumstances such as those to which allusion has been made earlier in this comment.

Engineering Information.

Our first article in this number is a very comprehensive description of the new Southern Pacific steamer *Creole,* this being the first steamer of any importance to be fitted with Curtis turbines as a propelling mechanism. The owners and builders of this epoch-making ship have afforded us every facility for obtaining the information, and the result cannot but be beneficial to all concerned. The generous and open-minded spirit which has actuated the officials in question is one that is met all too rarely in connection with manufacturing of most sorts, and in particular in connection with the building of ships.

It is, of course, only natural that a shipbuilder who has devoted years of his life and energy to developing methods of his own for accomplishing a certain result in a certain way, should desire to conserve all information regarding his methods and results to himself, or for the use of his own company, and to the exclusion of all others. At the same time it cannot but be recognized that any competitor desiring to obtain information of this character can not really be balked, if his attempt be made with a determination to accomplish results. Cases have come to our attention where engineers, disguised as laborers, have found it very easy to enter plants from which they had previously been rigidly excluded by the officials in charge, when presenting themselves at the office and desiring to inspect the processes of manufacture or methods of handling materials. As the information, therefore, cannot be kept secret from those most interested in obtaining it, there seems to be no good reason why the shipbuilder should not frankly take the engineering and shipbuilding public into his confidence in at least the broader general lines along which he is working, and give to the world the concrete results of his work, in the form of carefully prepared and well-illustrated descriptions of individual ships of importance.

Much comment has been made upon the extreme reticence observed in most quarters about the steam turbine, in its various forms and designs. Our present article gives a considerable amount of information on this subject, together with splendid photographs illustrating the Curtis turbine at all stages in the manufacture and assembling, and forms a refreshing contrast to the meager divulgences dictated by the almost mulish obstinacy of those usually having in charge the design and construction of such pieces of mechanism. It is beyond all question a fact that had the truth been known some years ago regarding the developments, along the line of which turbine engineers were working, the turbine would be to-day in a much more forward state, both in regard to design and in regard to extent of use. This follows from the fact that other engineering minds would have taken hold of the subject, inventions and innovations would have come more rapidly, and everything in connection with the design and operation would have been advanced very, very far beyond what is at present found to be the case. This advancement might have been of slight direct benefit to those at that time building turbines, but it could not well have been detrimental; and the advantage to the world would have been enormous.

Another phase of this subject is concerned with the accuracy and reliability of such information as finds its way into print. When the material is given by the builder, it is bound to be accurate, and, therefore, there can be little opportunity for misrepresentation in any particular. Where, however, as is too frequently the case, the seeker after information is obliged to use such as he can obtain from any irregular source which may present itself, there is bound to be great inaccuracy and frequent misrepresentation, sometimes in very important particulars. From the point of view, therefore, of being accurately represented in the eyes of the world, and particularly of the technical world, it behooves the manufacturer and shipbuilder to see that such information as is published is correct; and the only apparent way in which this result can be assured is by issuing the information direct to such as are interested in obtaining it.

ABSTRACT FROM RULES AND REGULATIONS OF BUREAU VERITAS.

EDITION OF 1905.

ARRANGED BY HARRISON S. TAFT.

PART VI.

39. General.

1. The three deck type of vessel is to be preferred in the construction of tank vessels.

2. The oil should go to the shell plating of the ship. If double bottoms are fitted, said spaces must be thoroughly ventilated.

3. There must be at least one continuous longitudina bulkhead throughout the oil spaces, deep water ballast tanks and cofferdams, said bulkhead extending to the top of the expansion tanks.

4. There must be a sufficient number of athwartship bulkheads to provide ample stability in filling or emptying the tanks. In steamers they are to be not more than 28 feet apart.

5. Each compartment must have an expansion tank extending above the "crown deck," the capacity of said tank being at least 6 percent that of the compartment to which it is fitted.

6. There must be a cofferdam at each end of the spaces devoted to an oil cargo, extending the entire breadth of the ship, and from the keel up to the highest point of the expansion trunkway. They are to be at least two frame spaces wide, and to be well ventilated.

7. Each oil compartment is to be tested before launching or in dry dock, by a head of water eleven feet above the "crown deck" of the tanks, or four feet above the top of the expansion tank hatch covers.

8. All cofferdams, pump rooms and other spaces must be efficiently ventilated.

9. It is recommended to locate the machinery in oil steamers entirely abaft the oil spaces, with the after cofferdam between the oil and the machinery spaces.

If the machinery is located amidships care must be taken to entirely isolate the shaft tunnel from the engine space with a cofferdam at both the forward and after ends of the machinery space, extending to the upper deck.

10. The galley, also the main and donkey boiler furnaces, are to be absolutely isolated from all contact with the oil cargo. It is advisable to locate the donkey boiler above the level of the main deck. No external door will be allowed to the donkey boiler firing space, unless it is placed on the upper deck abaft the oil tanks.

11. Electric lights to be fitted throughout on the double wire system. In all oil vessels, alternating current dynamos are absolutely prohibited, and single wire plants should not be fitted. The leads must not be run through the tanks, and no switches, cut outs or joints should be placed in the pump rooms.

12. As the safety of oil-carrying vessels depends upon perfect workmanship, especially of the riveted connections, it is advisable, in order to reduce the number of said connections, to use channels, Z-bars or other rolled bars and flanged plates, wherever possible.

13. Where the spaces at sides of expansion trunks are used as spare bunkers, or where any large quantity of coal is carried between decks, the deck in way of same must be coated with an approved composition.

40. Keels and Center Line Keelsons.

1. Plate keels.

(*a*) The flat plate type of keel only should be adopted, the plates being 20 percent heavier than in ordinary vessels. A single plate keel may be used where a double plate keel is called for (see section 5, paragraph 1-*b*) if the thickness of the keel plate is increased by 75 percent.

(*b*) The width of the plates should be 1½ times their width in ordinary vessels, in order to provide a secure fastening of said plates to the frames.

2. Center Line Keelsons.

(*a*) The center line keelson is to form the lower strake of the center line longitudinal bulkhead. It is to be worked continuously all fore and aft, maintaining its midship scantling for the 2/3 length amidships

(*b*) It is to be connected to the flat plate keel by double angle bars worked continuously. Said bars may be cut at an oil-tight bulkhead, but cutting is not recommended, even at a non-oil-tight bulkhead.

(*c*) The depth of said keelson must be such as to bring its lap with the center line longitudinal bulkhead plating above the floor plate brackets to said keelson.

41. Frames.

1. The frames should be cut short from the center line keelson by an amount not exceeding 9 inches, so as to provide a free flow for the oil to the pumps.

2. When the frames are cut at the second deck in two or more decked vessels so as to form an oil-tight flat, the between deck frames are to have a large bracket connection to the second deck stringer plate, equal in thickness to the frame's flange, with a single clip to said stringer.

42. Floor Plates.

1. All floor plates are to be secured to the center line keelson by double angle bar clips of at least 3 by 3 inches, and by a bracket plate of the same thickness as the floor plates. If said bracket plates are flanged, or have an angle bar on their diagonal edge, they may be 1/16 less in thickness than otherwise. Said brackets are to be on each side 1½ times the depth of the floors.

2. When the athwartship number is 70 and above, double zig zag riveting is to be adopted in each flange of the clips securing the floor plates and their brackets to the center line keelson or bulkhead.

3. The floor plates are to be worked up the bilge as in ordinary vessels. Floors may be worked straight on top, if brackets of the same thickness as the floors are fitted at the bilge and carried up as if the floors were turned up. When the athwartship number is below 50, said bilge brackets may be worked on alternate floors.

4. Suitable limber holes are to be cut in all floors, so as to allow of a free flow for the oil to the pumps.

43. Reverse Frames.

1. Reverse frames will be required whenever compound frames are used, as in ordinary vessels. They are all to extend to the "crown deck".

2. With bulb or Z bar frames, reverse frames are to be fitted to all floors.

3. Reverse frames may be dispensed with between decks above oil compartments, if webs or partial bulkheads are fitted in lieu of same.

44. Bottom Keelsons and Side Stringers.

1. Bottom keelsons.

(*a*) Said keelson angles may be cut at a transverse bulkhead, if the continuity of strength is maintained at said point by bracket plates of the same thickness as the keelson bars, with double clips to the bulkheads.

(*b*) When the keelson angles are 6 by 4 inches or above, said bracket plates should be flanged or have an angle bar of reverse frame size on their diagonal edge.

2. Side stringers.

(*a*) The width of the side stringers should be the same as the web frames. They can be worked intercostally between the web frames, or continuously through them, being securely connected to same at said point of intersection, as noted under web frames (Section 46).

(*b*) The side stringers are to be connected to the shell plating by intercostal angle clips of the same size as the deck stringer bars. Said clips are to be worked double for at least three frame spaces on each side of a transverse bulkhead.

(*c*) There shall be an angle bar at the inner edge of the frames. Double face angle bars are to be fitted to the inner edge of the stringer plate, worked along the diagonal edge of the bracket plates at the transverse bulkheads. Single bars of increased size may be substituted for the double faced bars. All of said stringer angles can be cut at an athwartship bulkhead.

(*d*) Side stringers 18 inches and above in width are to be supported by brackets of the same thickness as the frame's flange, spaced not over two frame spaces apart.

(*e*) When side stringers are cut at an athwartship bulkhead, bracket plates, equal to the thickness of the stringers and double clipped to the bulkhead, must be worked on both sides of said bulkhead in order to maintain the continuity of strength. The brackets are to be on each side at least three times the width of the stringer.

(*f*) When the side stringers are worked continuously through an athwartship bulkhead, the stringer plate at said point is to be increased to twice its ordinary width, with double angle bar collars, made oil-tight on each side of the bulkhead; or some other approved method is to be adopted.

(*g*) Side stringers in way of hold beams are to be ncreased in width to the width required for lower deck stringers.

TABLE 10.—BOTTOM KEELSONS: SIDE STRINGERS AND WEB FRAMES.

Number of Decks.	Bottom Keelsons.				Side Stringers. Hold Beams. Web Frames.				
	Beam in Feet.	Number.	Type of First Keelson.	Type of Second Keelson.	Depth to Upper Deck, Feet.	Side Stringers and Hold Beams. Number.	Web Frames. Width Inches.	Web Frames. Thickness 32nd.	Web Frames. Spacing Frames.
One	28	Two	DA + IP	DA	14	Two	16	10	6
	30		"	"	16	"	16	11	6
	34		"	"	18	"	18	12	6
	36		"	DA + KP	20	Three + SHB	18	14	6
	38		"	DA + IP + BP	22	"	20	14	6
Two	40		DA + IP + BP	"	24	Two	20	14	6
	41		"	"	26	Three	22	14	5
	42		DA + IP + KP + TA	"	28	"	22	15	5
	43		"	"	30	Three + SHB	22	15	5
	44		QA + DIP	QA + DIP	32	"	24	16	5

DA = Double Angles. IP = Intercostal Plate. BP = Bulb Plate. KP = Keelson Plate. TA = Top Angles. QA = Quadruple Angles. DIP = Intercostal Plate, extending above top of floors, SHB = Stronghold Beams.
Keelson plates to be in depth twice the broader flange of the keelson angle bars.

45. Floor Clips.

Lug pieces are to be fitted in way of all side stringers when bulb angle frames are adopted. If the stringers are not supported by brackets on alternate frames, said lugs must be of such a size as to take two rivets through the stringer bar. Each lug must have at least three rivets through the frame bar.

46. Web Frames.

1. Web frames are to be fitted in all vessels in way of the oil compartments or tanks, as per table 10. Their plates are to be of the same thickness as the tabular frames, and their width not less than four times that of the broad flange of said frames.

2. Double angles equal to the reverse frames are to be fitted on their inner edge, extending across top of floors to the center line.

3. Web frames may be cut at side stringers, or worked continuously at said point (the side stringers being cut). In either case quadruple clips of reverse bar size are to be fitted at said point, with a diamond plate in addition. Said diamond plates are to be in size 30 by 24 inches when the web frame is over 18 inches in width, but 24 by 20 inches when said width is 18 inches or less; the larger dimension being worked in the direction of the non-continuous member. The diamond plates are to equal in thickness the web frame plates.

4. Between deck web frames can be reduced 1/16 in thickness when of increased size and over 7/16 inches thick.

47. Deck and Hold Beams.

1. The depth and thickness of deck beams is to be the same as in ordinary vessels, except that no reduction will be allowed in the scantlings of half beams of the upper or second decks in way of oil compartments.

2. Strong beams are to be worked at the "crown deck" in way of web frames, in all cases. Said beams are to be secured to said webs by large plate brackets.

3. Beams at ends of hatches in way of oil compartments are to be of increased size, as in ordinary vessels.

4. When the deck plating is flanged in way of the expansion tanks, a fore-and-after is to be fitted in way of the half beams.

5. When the upper deck beams are cut in way of an expansion tank, they must be secured to the tank side plating by brackets of the same size as those at sides of ship.

6. Hold beams, when required (see table 10) are to be fitted in way of each web frame.

7. Beam knees in way of oil compartments (when of plate) are to be on each side at least three times the depth of the beam to which they are secured.

1. Stringers.

48. Deck Stringers and Deck Plating.

(*a*) In all cases the deck stringers are to be worked continuously through a transverse bulkhead, being worked in all other respects as in ordinary vessels.

(*b*) When the gunwale bar forms an oil-tight connection between the shell and the deck plating, it must be ½ inch larger in size than otherwise.

2. Plating.

(*a*) Steel decks to be fitted as in ordinary vessels, but in no case is the thickness of a steel deck forming the "crown deck" to be less than ⅜ inch thick, or that forming the top of the expansion trunk less than 5/16 inch thick.

(*b*) Inside of the expansion trunk it is recommended that the deck be not plated. The deck in way of both longitudinal and transverse bulkheads must be plated over for a width of at least 2 feet on each side of said bulkhead plating.

(*c*) The deck plating in way of hatches, etc., must be of increased thickness, as in ordinary vessels. When oil hatches on the upper deck are continuous, the deck plates next to them on either side must be worked double for one-half length amidships.

(*d*) The packing between top of beams and outside deck strakes to be fitted in short pieces, or washers used so as to allow for the free escape of gases.

49. Stanchions.

1. Quarter stanchions are to be fitted in each oil compartment, well riveted to floors and deck beams in all vessels of over 42 feet beam; one such stanchion being fitted when the length of a compartment is 24 feet or less, but two when said length is above 24 feet. Channel sections are recommended.

2. Heavy beams fitted with large brackets to the web frames and center bulkhead buttresses may be adopted in lieu of the quarter stanchions, if all of the transverse members are increased to meet approval.

50. Shell Plating.

1. See section 40, paragraph 1, for plate keels. Otherwise the shell plating is to be as in ordinary vessels, except that no reduction will be allowed aft up to the counter in screw steamers with machinery fitted aft.

2. All butts in way of the oil compartments should be overlapped.

51. Engine and Boiler Spaces.

1. With machinery placed aft.

(*a*) The same arrangement of side stringers and web frames as used in the oil compartments is to be used in the machinery space.

(*b*) The web frames are to be connected to the margin plates by double angles, and a gusset or half diamond plate riveted to the reverse frames and the tank side plating.

(*c*) The scantlings of all members of a water ballast tank worked under said spaces must be of increased size as for a similar tank worked amidships, as per section 25.

52. Shaft Tunnel.

Entrance to said tunnel must be by a trunkway from the main deck at both ends of the tunnel, the forward entrance being put abaft the coffer dam at the aft end of the engine room when the machinery is located amidships. When the tunnel passes through the above cofferdam, care must be taken to secure absolute oil tightness. Said tunnel must have at least two efficient deck ventilators.

53. Bulkheads.

TABLE II.—SCANTLINGS OF LONGITUDINAL AND ATHWARTSHIP BULKHEADS.

Athwartship Number. B + D	Plating.			Horizontal Stiffeners.			Vertical Stiffeners.		
	Lower Third	Middle Third	Upper Third	Breadth and Thickness of Plates.		Size of Angles.	Size of Angles.		Maximum Spacing.
	32nd	32nd	32nd	Inches.	32nd	Inches 32nd	Inches	23rd	Inches.
42 to 46	12	11	10	9 ×	11	3 × 3 × 12	5 × 3 × 12 (Angles)		24
46 " 52	13	12	11	10 ×	12	3 × 3 × 12	5½ × 3 × 12		24
52 " 56	14	13	12	10 ×	13	3½ × 3½ × 12	6 × 3 × 14	Bulb Angles	25
56 " 60	15	14	12	11 ×	14	3½ × 3½ × 12	6 × 3 × 15		25
60 " 64	16	14	12	12 ×	15	3½ × 3½ × 12	6½ × 3½ × 15		26
64 " 67	16	15	13	13 ×	15	3½ × 3½ × 14	7 × 3½ × 15		26
67 " 70	17	15	13	14 ×	16	3½ × 3½ × 14	7 × 3½ × 16		27
70 " 73	17	15	13	15 ×	16	3½ × 3½ × 14	7 × 3½ × 16		27

1. General.

(*a*) The horizontal and vertical stiffeners of table 11 are to be worked on opposite sides of the bulkheads.

(*b*) All horizontal plate stiffeners are to have an angle bar connection of the size given in table 11, to the bulkhead plating, with a corresponding face angle at face of the stringer.

(*c*) Oil-tight bulkheads must be made oil-tight without the use of felt, packing or white lead.

(*d*) It is advisable that the bulkheads and all their stiffening angles, etc., be calked on both sides.

2. Athwartship Bulkheads.

(*a*) The horizontal stiffeners should be worked in way of the side stringers, and be well riveted to the bracket plates connecting the bulkheads to said stringers (see section 44, paragraph 2-e). The vertical stiffeners shall be secured to the floors, and to the deck at their upper end by bracket plates of the same thickness as the stiffeners.

(*b*) Said bulkheads are to have a single angle bar frame, double riveted in each flange. They are also to have a single angle bar connection to the deck plating, double riveted in each flange.

(*c*) Bulkhead shell liners are to be made of such a width as to take one row of rivets on each side, outside of the frame bars.

(*d*) A vertical web frame equal to the thickness of bulkhead plating, not less than 24 inches wide at the bottom, having face angle bars and connected to the floors and deck plating by brackets, is to be worked midway between the center line and side of ship on each side of the ship, wherever the vessel's beam exceeds 36 feet. Two such web stiffeners are to be fitted on each side wherever the beam exceeds 42 feet.

(*e*) Horizontal stiffeners of and over 12 inches wide are to be fitted with bracket knees of same thickness as the stringer, spaced not over 6 feet apart.

3. Longitudinal or center line bulkhead.

(*a*) The scantling of the plating and stiffeners it to be the same as for the athwartship bulkheads, as per table 11, except for the bottom strake, for which see Section 40, paragraph 2-a.

(*b*) The vertical stiffeners are to be spaced as are the frames, being well bracketed to the floors, and to the deck beams at their upper ends.

(*c*) Horizontal plate stiffeners should be worked in way of the athwartship bulkhead plate stiffeners, being secured to same by bracket plates of same thickness, said bracket plates being on each side (measured from the bulkhead) three times the width of the stiffener. A bracket plate of equal dimensions is to be fitted on the opposite side of the bulkhead.

(*d*) The plating of said bulkheads may be worked continuously all fore and aft, or cut at athwartship bulkheads, the latter being worked continuously. The bottom strake of plating forming the center line keelson must be worked continuously in all cases.

(*e*) The longitudinal and athwartship bulkheads are to be secured together by a single angle bar of bulkhead frame bar size, double riveted in each flange, or by double angle bars single riveted.

(*f*) At their ends said bulkheads must taper for a distance of not less than one-third the depth of the bulkhead from keel to crown of tank.

(*g*) Vertical web plates, the full height of the bulkhead, are to be worked on said bulkhead in way of the web frames at the ship's side. The plating of said webs is to equal that of the bulkhead, being not less than 2 feet broad at the foot, and have bracket plates to both floors and deck beams. The face is to be stiffened by an angle bar of reverse frame size.

(*h*) When the center line bulkhead is carried up to form a central division in the expansion trunks, it may be 1/16 inch less in thickness than the expansion trunk sides, with the stiffness of reverse bar size, spaced as are the main frames. When said bulkhead is made oil-tight in said trunks, the scantlings must be the same as the trunk sides.

4. Cofferdam bulkheads.

(*a*) Said bulkheads are to be efficiently connected together by gusset and bracket plates.

(*b*) Large bracket plates or webs must be fitted and extend down to the bottom plating against the cofferdam bulkheads outside of the oil compartments.

(*c*) No door or sluice valve shall be cut in a cofferdam bulkhead below the "crown deck."

(*d*) In two deck vessels doorways cut in the between deck spaces must be at least 18 inches above the deck bars, and have suitable water tight doors.

54. Expansion Trunks and Hatchways.

1. An expansion trunk or tank must be fitted to all oil compartments. Said tanks are to extend above the "crown deck," each tank having a capacity of at least 6 percent of that of the oil compartment to which it is fitted. The plating of said tank is to be of the same thickness as the upper part of bulkhead, as per table 11.

2. The stiffeners on both sides and ends are to be of the same scantling and spacing as the tabular frames. They are to be in line with the deck beams, being secured to same at top and bottom by bracket plates of the same thickness as the stiffeners.

3. Web frames equal in thickness to that of the trunk side plating are to be fitted in the expansion tanks at ends of all hatchways.

4. The trunk side plating is to be carried down and connected to the half beams in way of all hatches in said tanks, as in ordinary vessels.

5. Hatchways with an oil-tight metal cover must be fitted over each expansion tank, to allow of proper ventilation of said hold.

55. Butt Straps.

1. Lapped butts are recommended for the keel plate. Double straps must be fitted if butt straps are adopted.

2. The center line keelson is to have double straps when butt straps are adopted.

3. Web frames to have lapped butts to floors.

4. All shell butts are to be overlapped in way of all oil compartments. Double straps must be fitted if butt straps are adopted, with three complete rows of rivets.

56. Riveting.

1. No rivet of less than ¾ inch diameter will be allowed in an oil compartment subject to pressure. Otherwise the riveting in way of the oil tanks to be as given in table 9 and section 24, unless otherwise herein specified.

2. In oil-tight bulkheads and all other parts where the pressure comes upon both sides, and more than two plates are to be riveted together, it is recommended to adopt the flush head countersunk rivet, or the plug neck rivet. Care must be taken that the rivet heads project beyond the plate at least ¼ inch, and that there is sufficient spread on the heads to prevent them from being drawn. Pan-headed rivets, where used, must be swollen out under the neck, in order to fill the drift of the punch, and great care must be taken that each is driven up fair. Rivets in the bracket knees connecting keelsons and stringers and floors, where cut at the transverse and longitudinal bulkheads, are to be finished full or convex as in boiler work.

3. Single riveting will not be allowed in any shell plating seam in way of the oil compartments.

4. Lugs on bulb frames must have at least three rivets through the bulb frame bar.

5. There are to be not less than six rivets connecting the between deck frame stringer bracket to said frame, with the same number in each flange of the connecting angle (see Section 41).

6. The following to be single riveted:

(*a*) Butts and seams of a non-oil-tight center line bulkhead above bottom strake.

(*b*) Seams of expansion tank plating.

7. The following to be double riveted:

(*a*) Butts and seams of all oil-tight and cofferdam bulkheads (double chain).

(*b*) Lower seam of a non-oil-tight center line bulkhead.

(*c*) All oil-tight bulkhead frame bars, oil-tight gunwale bars, corner angles and collars subject to oil-tight pressure (zig zag).

(*d*) Seams of "crown deck" plating (chain).

(*e*) Butts of "crown deck" plating (treble when required).

(*f*) Butts of expansion tank plating.

(*g*) Single frame bars of all web frames (zig zag).

(*h*) Bracket plates which are fitted to maintain continuity of strength (zig zag).

(*i*) All shell plating seams in way of oil compartments (chain).

(*j*) Butts of web frames (see 8-*c* below).

8. The following to be treble riveted:

(*a*) Butts of the center line keelson throughout.

(*b*) Butts of the shell plating throughout oil compartments.

(*c*) Connection of web frames to floors.

(*d*) Brackets to stringers at bulkheads.

57. Spacing of Rivets.

	DIAMETERS.
1. (*a*) Butts and seams of expansion tank plating (single riveted)	3
(*b*) Butts and seams of deck plating forming top of expansion tank (single riveted).	
2. (*a*) Longitudinal seams of shell plating (double chain),	
(*b*) Butts and seams of all oil-tight and cofferdam bulkheads (double chain),	
(*c*) Butts and seams of "crown deck" plating,	
(*d*) Butts and seams of expansion tank plating (double riveted),	3½
(*e*) Butts and seams of deck plating forming top of expansion tank (double riveted),	
3. (*a*) All oil-tight bulkhead frame bars, corner angles and collars subject to oil pressure (double zig zag),	
(*b*) Bulkhead stiffeners, calked,	4
4. (*a*) Butts and seams of a non-oil-tight center line bulkhead above the bottom strake,	
(*b*) Beam Knees to frames,	
(*c*) Bracket plates fitted to maintain continuity of strength (double zig zag),	4½
5. Bulkhead stiffeners not calked,	6
6. Frames to shell plating and beams to deck plating	6½
7. Single frame bars of all web frames (double zig zag, each row),	7
8. Beam knees to have at least 6 rivets in each knee.	
9. Side stringer shell clips.	
(*a*) 4 by 4-inch angle bar or over; number of rivets in each flange in each frame space,	7
(*b*) Less than 4 by 4-inch angle bar: number of rivets in each flange in each frame space.	6

58. Oil Fuel Installation.

1. In all cases a settling tank must be fitted, into which the oil shall be pumped before passing to the burners, so as to separate the oil from any water which may have accidentally found its way into the tanks or pipes.

2. Wells shall be formed at the ends of the oil fuel tanks in the double bottom, in order to collect possible leakage of oil or water.

3. When an oil fuel tank is adjacent to a cargo hold, proper means (such as cofferdams) must be adopted to prevent the cargo from coming in contact with the sides of the tank, and oil wells fitted round the tank in

the cargo or machinery space, in order to collect any leakage which might find its way through the tank bulkheads into these spaces. These wells must be at least two feet deep, be separate from the hold wells or bilge, and be fitted with sounding pipes and suctions.

4. Where oil fuel tanks are close to the boilers or uptakes, special means must be taken to properly insulate the boilers or uptakes from the tanks.

5. There must be a separate pumping system to the oil tanks and wells, independent from that of the bilge or ballast tanks.

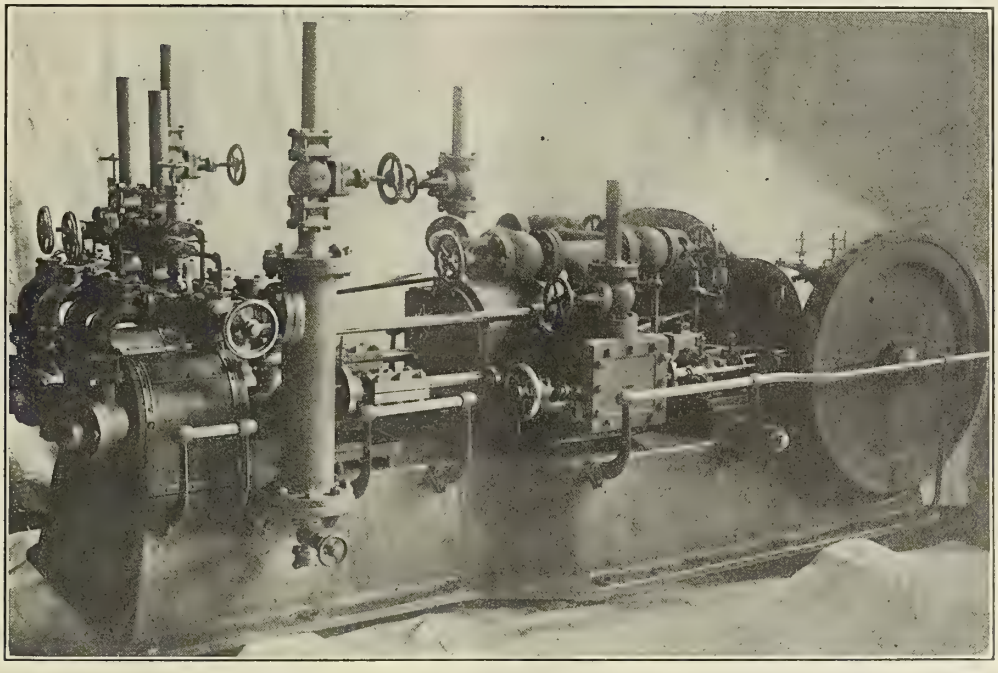
59. Compasses.

The standard compass should be at least 33 feet from any continuous current dynamo or electric motor, and 50 feet from any alternating current machine. No single wire is to be nearer a compass than 16 feet. If it is impossible to keep wires away, the double wire or concentric system must be adopted in the vicinity of the compass. Chronometers should be kept at a fair distance from dynamos and leads.

ENGINEERING SPECIALTIES.

Linde Refrigerating Plant on Creole.

The refrigerating machinery is carried on the main deck in a separate compartment just aft of the engine room hatch, with cold storage boxes for the ship's provisions on the upper deck, and cold storage rooms for carrying perishable freight on the main deck forward of the refrigerating machinery space, on each side of the engine hatch. This plant was supplied by the American Linde Refrigeration Co., of New York, and consists of the following parts: One duplex marine type machine, three sections of double pipe ammonia condenser, two brine coolers, two brass fitted duplex brine pumps, one galvanized water tank and coil for same, one brass fitted duplex water pump for the drinking water, one brass fitted duplex pump in main engine room for circulating the water through the condenser coils.



The whole arrangement of this plant is such that each room can be regulated and worked independently of the others, and to insure against a breakdown of any kind, the plant is installed in duplicate throughout and is designed to maintain a temperature of 15 degrees with cooling water at 80 degrees, when running between New York and the south. The cooling is done on the brine circulation system, with coils in the chambers, which coils are divided into six sections, each section having a main delivery and return pipe direct into the refrigerator tank rooms, which rooms are situated in the cold storage space just outside of the refrigerating engine room.

The refrigerating machine has two ten-ton double-acting ammonia compressors placed tandem to a compound steam engine, each compressor being driven by the prolongation of the steam piston rod, which is connected to the compressor piston rod by a removable and adjustable coupling. The machine is self-contained upon a massive cast iron bed-plate, placed on a pitch pine seating and bolted through the deck. The steam connections to the compound steam cylinder are so arranged that either cylinder may be run at high pressure or compound as required. The steam engine is designed for a working pressure of 150 pounds to the square inch, and when at sea, the exhaust will be carried to the main engine condenser. The ammonia connections on the machine are so arranged that each cylinder has a connection to the double-pipe condenser with pump out connections.

The double-pipe condenser is of the American Linde type, and is in three sections, so that in the event of a breakdown of one of the sections, the whole machine can operate on the remaining two, the condenser being of sufficient capacity to do this work.

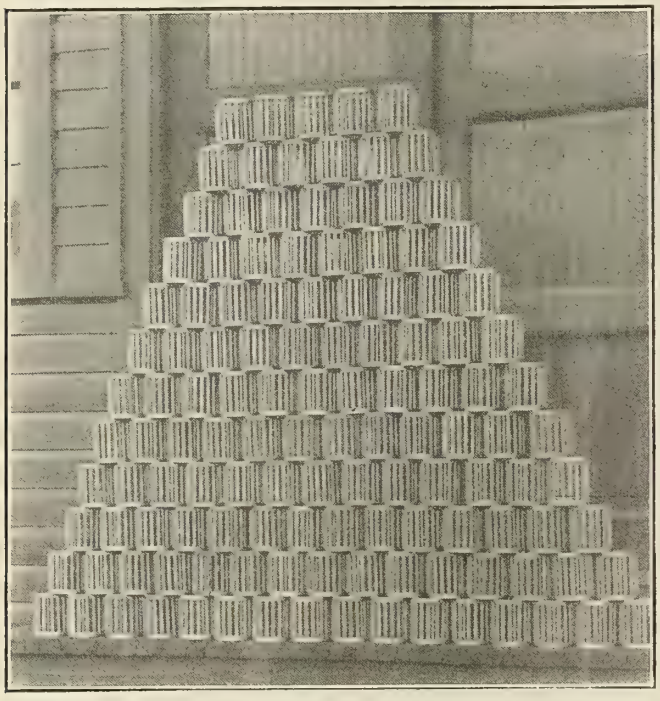
There are two brine coolers, each connected to one compressor, but with the connections so arranged that either or both may be run to either or both of the compressors, or vice versa. The brine coolers consist of a heavy centrifugal wrought iron tank, with heavy water-tight cover so arranged that the circular coil can be readily removed. Each tank contains a nest of four circular coils of 1¼-inch extra heavy piping, through which the ammonia is expanded for cooling the brine. The tanks are provided with automatic air vents to pass off any gas that may be generated.

The brine circulating pumps are of the ordinary duplex brass-fitted low service type, specially designed and supplied by the Eppington Carpenter Co., of Pittsburg, Pa., and are cross-connected with each other and with each of the brine tanks in such a way that either or both may be run to either or both of the

brine tanks, if necessary, and in case of a breakdown, each pump is of sufficient capacity to handle the whole brine circulation throughout the ship.

Roller Bearings for Marine Railways.

The photograph shows an outfit of roller bearings 5 inches long, and fitted for 3½-inch axles recently made for the car trucks of a marine railway by the Bantam Anti-Friction Company, Bantam, Conn. The cages are made of the best quality of



bronze and the separating posts and rollers of the best quality of screw steel, the whole being put together in such a manner as to operate smoothly, and to have a great deal of endurance. These bearings are designed especially for the traveling cranes and the heavy car trucks to be found in repair plants using marine railways, and from all accounts have given excellent satisfaction in service.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 355.—Please give me the rule for finding the pitch of a propeller. M. G. C.

A.—To determine the pitch of a given propeller three measurements are necessary. These are:

(1) The radius OA at which the pitch is desired.

(2) The angle or part of the complete circumference corresponding to the distance on the blade between A and B, the two points between which the pitch is to be found.

(3) The advance BC along the line of the shaft, corresponding to this part of the complete revolution.

In the figure, A and B are points on the face of the blade, and are at a constant distance OA from the shaft center line OO. AC is an arc of a circle which lies in a plane through A, and perpendicular to the shaft. The angle AOC is therefore the one referred to in (2), and the distance BC is the corresponding advance. Then BC is the same fraction of the entire pitch that AOC is of a complete circle, or that the length AC is of a complete circumference with OA as radius. This complete circumference will be $6.2832 \times OA$. Hence the proportion:

$$AC : 6.2832\ OA :: BC : \text{pitch}$$

$$\text{or pitch} = \frac{6.2832 \times OA \times BC}{AC}$$

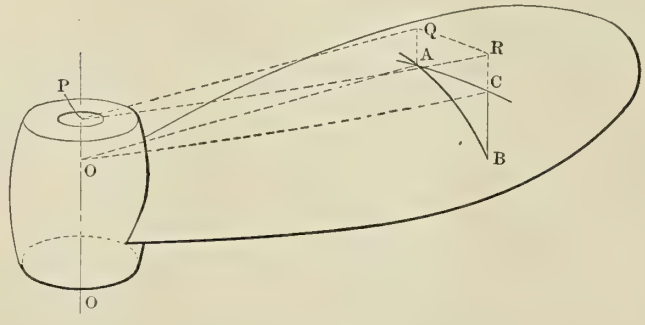
AC is however, not as easy to measure as AB, so that we may put for AC its equal $\sqrt{\overline{AB}^2 - \overline{BC}^2}$ and hence

$$\text{pitch} = \frac{6.2832 \times OA \times BC}{\sqrt{\overline{AB}^2 - \overline{BC}^2}}$$

A brief outline of the operation is as follows: (1) Select the points A and B at and between which the pitch is desired, making sure that $OA = OC$, and lay out on the blade a line AB at a constant radial distance equal to OA from the center line of the shaft. This can be done by squaring down from a straightedge or other reference line $PQPR$ placed across the hub and at right angles with the shaft. Measure the length AB.

(2) The propeller leveled up, measure the distance BC from a level through A vertically down to B. Or, if the propeller cannot be leveled, measure from B in a direction parallel to the shaft, out to a line through A and running at right angles to the shaft. Or, measure from Q down to A, and from R down to C, and take their difference, BC.

(3) Multiply the radius OA by 6.2832 and by the length BC, all in the same units of measure.



(4) Square the lengths AB and BC, subtract the square of the latter from that of the former, and take the square root of the remainder.

(5) Divide the result found in (3) by that found in (4) and the result will be the pitch desired.

Thus, for example, suppose $AB = 15$ inches, $BC = 9$ inches, and $OA = 40$ inches. Then $6.2832 \times 40 \times 9 = 2262$. Also $\sqrt{225 - 81} = 12$ and $2262 \div 12 = 188.5$ inches $= 15.7$ feet $=$ pitch.

The foregoing assumes the propeller to be of uniform pitch.

If, instead, the pitch is variable, the operation is precisely the same, but the result found must be considered merely as the mean or average value of the pitch between the points A and B. For other parts of the blade a similar process will give the corresponding pitch.

As a rough and ready rule it may be remembered that the pitch of a propeller will equal the length of a circumference at the place on the blade where the slope of the face is 45 degrees, or where it is equally inclined to the shaft and to the transverse direction. Starting near the shaft, the inclination to the longitudinal is small, but increases toward the tip. Let r be the radius where the inclination is the same to both directions. Then $p = 2\pi r = 6.2832\ r$. In this way an approximate idea may be obtained of the pitch of a wheel by estimate without special measurement, except for the radius or diameter at which the condition of equality of slope is fulfilled.

The details of the general method as described may be varied in many ways, but the description given will serve to show the general principles involved, and with a reasonable amount of mechanical skill, no trouble will be found in carrying out the measurements required.

Q. 358.—What back pressure is experienced in a motor boat without muffler, and with exhaust nozzle discharging below the water line? Is there any tendency in this case for the water to go back into the exhaust pipe and engine when the engine has been stopped?
How is an under water exhaust arranged? X. Y. Z.

A.—In a motor boat where the exhaust nozzle discharges below the waterline, the back-pressure is one-half pound for every foot of depth below the water surface at the point where the discharge nozzle is placed. Of course, where the discharge is below the water surface, there is no need for a muffler.

2. With an under-water exhaust there is a tendency for the water to go back into the exhaust pipe and into the engine when the engine is stopped and the gases cool off and form a vacuum. Under-water exhausts have to be fitted with a relief, or air valve, that will allow the atmosphere to come into the exhaust pipe the moment a vacuum begins to form. This relief valve should be placed near the engine, and may be of the automatic type, or an ordinary globe valve will serve the purpose. If the latter is used, the engineer will have to open it by hand the moment he stops the engine, which of course involves the human element of forgetfulness. On the other hand, the automatic valve sometimes sticks, and then the water is thrown into the cylinders and causes trouble.

3. The general arrangement for an under-water exhaust is an elbow or short section of pipe outside of the hull arranged to point aft; for it should be borne in mind that each explosion exerts an impulse equal to the pressure multiplied by the first velocity, and if the nozzle is pointed aft the reaction of this will tend to drive the boat ahead. If this elbow or nozzle is not fitted, and the exhaust is permitted to discharge at right angles to the boat's surface, the impulses or shocks will also be at right angles, and this sometimes sets up very serious vibration in the hull. H. J. G.

TECHNICAL PUBLICATIONS.

Marine Engineering. A Manual, by Hermann Wilda. Size, 7¼x10½ inches. Pages, 416; figures, 364; tables, 108. Hanover, Germany, 1906. Doctor Max Jaenecke, publisher. Price, $6.00 net. (In Great Britain, one pound net).

This is the text of the work which we noticed at page 162 in our issue for April. The subject is taken up in fourteen chapters, covering respectively: Ship Resistance and Engine Power; The Testing of Engines; Determination of the Indicated Power in Designing New Engines; Determination of the Cylinder Dimensions; Determination of the Thickness of the Cylinder Walls; Cylinder Fittings and Steam Pipes; Piston, Piston Rods, Cross Heads and Connecting Rods; Valves and Valve Gears; Crank Gear and Weights; Condensers; Pumps; Arrangement of Engines with regard to Spaces and Weights; Propellers; The Steam Turbine.

The text-book contains the calculations for the marine steam engine and its various parts, and is well supplemented by the index. In addition to calculations, tables are given of designs actually carried out in practice, which should be of valuable assistance in proving the correctness of new designs by comparison with approved types. Everything is thoroughly up-to-date, and well illustrated, and is given in great detail, with representative examples from German, English and American practice.

Taken in conjunction with the portfolio of plates previously noticed, the whole forms a reference book of unusual value and scope, and one which will commend itself to all designing (marine) engineers who see it.

The American Steel Worker. By E. R. Markham. Size, 5½x7¾ inches. Pages, 367; figures, 163. New York, 1906. The Derry-Collard Company. Price, $2.50.

This is the second edition of a work covering an experience of twenty-five years of actual practice in various branches of machine shop operation. This experience has taught the author that much more depends upon the condition of the various cutting tools used than is generally realized. The subjects of tempering, annealing, refining and hardening of steel are taken up in much detail, the book being profusely illustrated with devices required and being full of useful kinks. Particular attention is paid to springs, and to the general treatment of small articles, in the way of dies and reamers. The work should prove very useful to those having much to do with tools in general, and machine shop tools in particular.

Steam Turbines. By Frank Foster, M. S. Size, 5½x8½ inches. Pages, 458; figures, 249. The Scientific Publishing Company, Manchester, England. Price, 10/6 net.

In this book an attempt has been made to avoid deeply involved mathematics, and not to insist too strongly upon the attainment of the highest thermal efficiencies, it being recognized that numberless modifying practical influences invariably militate to affect the ultimate commercial result of the operation of any such piece of mechanism. In other words, it is the commercial efficiency upon which emphasis is laid. The book is not merely a popular description of existing machines, but it takes the subject up in a common sense sort of way, giving a great many practical details which affect the efficiency.

Under the heading of marine turbines, we find a number of pages, with good illustrations, of plants of various sorts and for varying purposes. The subject of friction in the turbine is taken up, as also the relation between the turbine and the propeller which it operates, and between the turbine and the condenser which provides its vacuum. The work appears to be well worthy of careful consideration.

The Analysis and Softening of Boiler Feed Water. By Edmund and Fritz Wehrenfennig. Translated by D. W. Patterson, M. E. Size, 5¾x9 inches. Pages, 290; figures, 171. New York, 1906. John Wiley & Sons. Price, $4.00.

In the translator's preface it is stated that the work of translation was taken up first for personal information, but that the data proved so practical that the book should be of considerable value to those not familiar with the chemical details of the purification of water. The Weir system of distributing the water and the displacement system of introducing the lime and soda ash solutions foreshadow desirable improvements to all types of softeners now in use in this country.

This is the second edition of the work, the special purpose of which is to give a water purifying plant a guide to the operation of its outfit, and an assistance in the installation of its machinery. It sometimes happens that in spite of the most complete chemical analysis, the purification will not always accomplish uniformly satisfactory results, because the person intrusted with its operation lacks knowledge of the leading conditions on which good results depend. It is the purpose of this book to fill a niche of this character, and to furnish the special information required for the use of the operator. The drawings are given in great detail and profusion, and show various types of plants fitted for this purpose.

Catechism on Producer Gas. By Samuel S. Wyer, M. E. Size, 4½ by 6½ inches. Pages, 42; figures, 3. New York, 1906. McGraw Publishing Company. Price, $1.00 net.

This little work contains 287 questions, with proper answers, covering a brief discussion of the types of apparatus; methods of manufacture; history; present and future uses and advantages of producer gas. It starts with basic definitions, and includes such items as the cleaning of the gas, and the handling and construction of the producer.

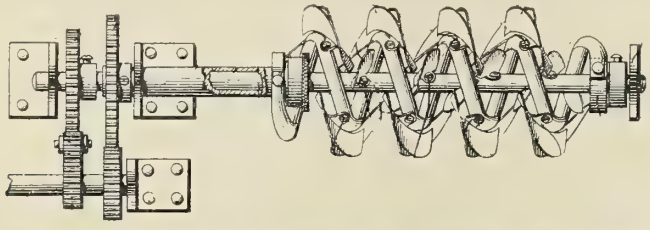
The Pacific Mail steamship *Manchuria*, of 13,638 tons, which is reported lost on one of the islands of Hawaii, is a sister ship to the *Mongolia*, illustrated on page 352 of our September number. These two ships, which were built by the New York Shipbuilding Company, of Camden, N. J., were at the time they were put into commission, two years ago, the largest vessels which had yet been constructed in the United States. It is a rather noteworthy fact that the four largest ships ever built in this country, the other two being the *Dakota* and *Minnesota*, should have been constructed on the Atlantic coast and put into operation in Pacific waters. The *Mongolia* has since gone ashore.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

823,476. PROPELLER FOR MARINE VESSELS. JOSEPH DELA MAR, NEW YORK, ASSIGNOR OF ONE-HALF TO JACOB J. NICHOLS, BROOKLYN, N. Y.

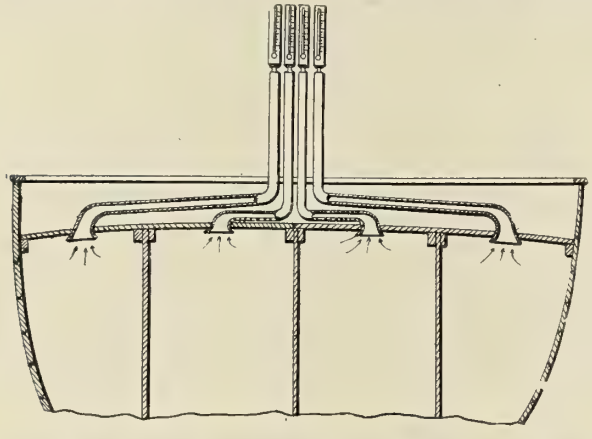
Abstract.—The improvement consists in the combination of a set of propeller-blades arranged at suitable intervals and angles on a spirally-



formed rib and another set of propeller-blades arranged within the spiral rib of the first-mentioned set, but entirely disconnected. Ten claims.

824,573. MEANS FOR PROTECTING SHIPS FROM FIRE. HAYWOOD W. McKINNE, KINSTON, N. C.

Abstract.—This invention consists, essentially, of a series of air-passages having communication with the respective compartments and converging



to a central point where thermometers are so placed as to indicate the temperature of the air circulating through the passages. Two claims.

824,726. VENTILATOR FOR SHIPS, BOATS, &c. EUGENE KOLBASSIEFF, ST. PETERSBURG, RUSSIA.

Claim.—2. Ventilator for ships, boats and the like comprising two disks having a space between them, tubes arranged in the space between said disks and a rotatably-mounted hollow spindle carrying said tubes and having openings to communicate with the interior of the ship. Seven claims.

824,727. STARTING AND MANEUVERING APPARATUS FOR TURBINE-STEAMERS. JOHN KRAFT, JEMEPPE-SUR-MEUSE, NEAR LIEGE, BELGIUM.

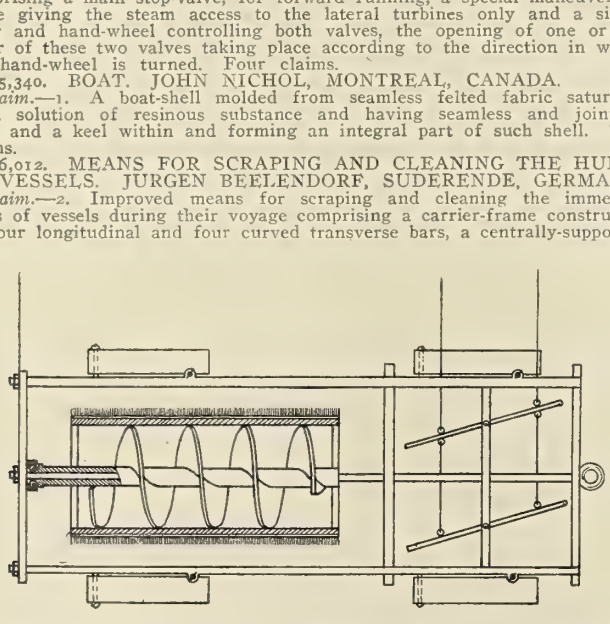
Claim.—1. A starting and maneuvering apparatus for turbine-steamers comprising a main stop-valve, for forward running, a special maneuvering-valve giving the steam access to the lateral turbines only and a single lever and hand-wheel controlling both valves, the opening of one or the other of these two valves taking place according to the direction in which the hand-wheel is turned. Four claims.

825,340. BOAT. JOHN NICHOL, MONTREAL, CANADA.

Claim.—1. A boat-shell molded from seamless felted fabric saturated in a solution of resinous substance and having seamless and jointless ends and a keel within and forming an integral part of such shell. Two claims.

826,012. MEANS FOR SCRAPING AND CLEANING THE HULLS OF VESSELS. JURGEN BEELENDORF, SUDERENDE, GERMANY.

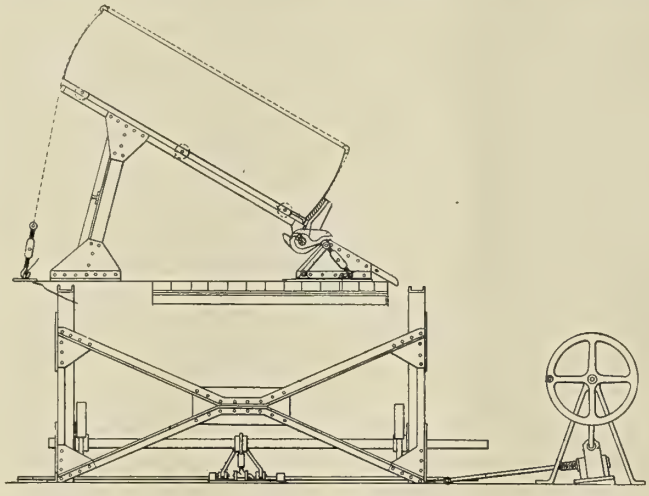
Claim.—2. Improved means for scraping and cleaning the immersed hulls of vessels during their voyage comprising a carrier-frame constructed of four longitudinal and four curved transverse bars, a centrally-supported



shaft fixed in said carrier-frame, a cylindrical shell for the reception of a rotary scraper on its exterior surface provided with a concentric nave, said nave fitting and rotatable on the aforesaid shaft, a propeller-screw fast to the nave inside the cylindrical shell, rudder-plates for raising and lowering the device in the water, adjustable presser-plates for insuring the contact between the device and the hull, means for operating the rudder-plates on board and means for holding and guiding the device alongside the vessel. Four claims.

825,917. GEAR FOR SUPPORTING AND LAUNCHING LIFE-RAFTS. HARRY MATSON, HAVRE, FRANCE.

Claim.—1. In gear for supporting and launching a life-raft, in combination, inclined guide-rails, means for supporting said rails, a rotatable



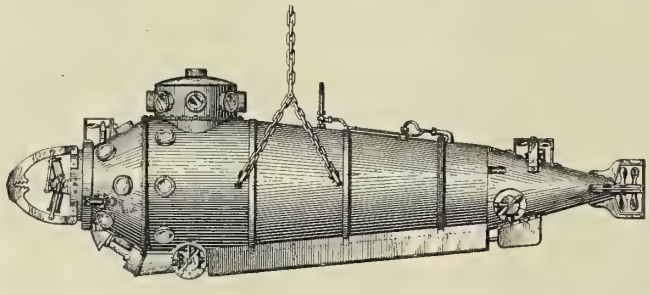
shaft mounted in suitable bearings transversely of and below said rails, triggers fast on said shaft for supporting the raft, and releasable means for controlling the rotation of said shaft. Eight claims.

826,421. BOAT. NELSON GILBERT, ALEXANDRIA, CANADA.

Claim.—1. In a boat of the class described, the combination with a body, of a cabin mounted thereon and comprising collapsible side walls and a roof, said side walls comprising sections capable of being placed within the body and covered by the roof. Seventeen claims.

826,868. SUBMARINE VESSEL. SANTIAGO NEVES, VALPARAISO, CHILE.

Abstract.—The purpose of the invention is to provide a submarine vessel adapted to contain a single individual, who is kept supplied with atmospheric air from above the water-level and who may have telegraphic or telephonic communication with attendants on the surface of the water, and to provide a simple, economic, and reliable means for propelling the boat ahead, sternward, or to starboard or port, or up or down, thus enabling

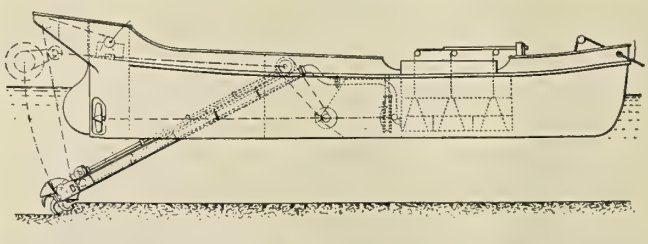


a person to descend to depths unattainable by divers having the ordinary divers' apparatus, and whereby the person in the vessel having absolute control of the vessel can move in any required direction, the vessel at its bow being provided with suitable bull's-eyes, enabling the occupant of the vessel to observe upon all sides of the vessel, as an electric light may be provided within the vessel.

Another purpose of the invention is to provide a vessel especially adapted for submarine explorations or for operating tools or tackle at points below the water being also adapted to raise heavy articles to the surface of the water or harness such objects, so that they may be otherwise raised. Six claims.

826,993. DREDGING-MACHINE. LOUIS COISEAU, PARIS, FRANCE.

Claim.—1. A suction dredging-machine having a vane-wheel bearing on the surface which is required to be dredged, a half-drum in which the vane-wheel is rotatably mounted, a suction-pipe, a pump or an ejector



connected to the upper part of the suction-pipe, an orifice provided in one of the cheeks of this drum, for receiving the lower end of the suction pipe, and an adjustable opening provided in the other cheek of the drum opposite to the suction-orifice. One claim.